Strategic Supply Chain Design
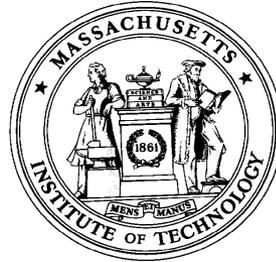
**Massachusetts Institute of Technology
Sloan School of Management**

Strategic Supply Chain Design

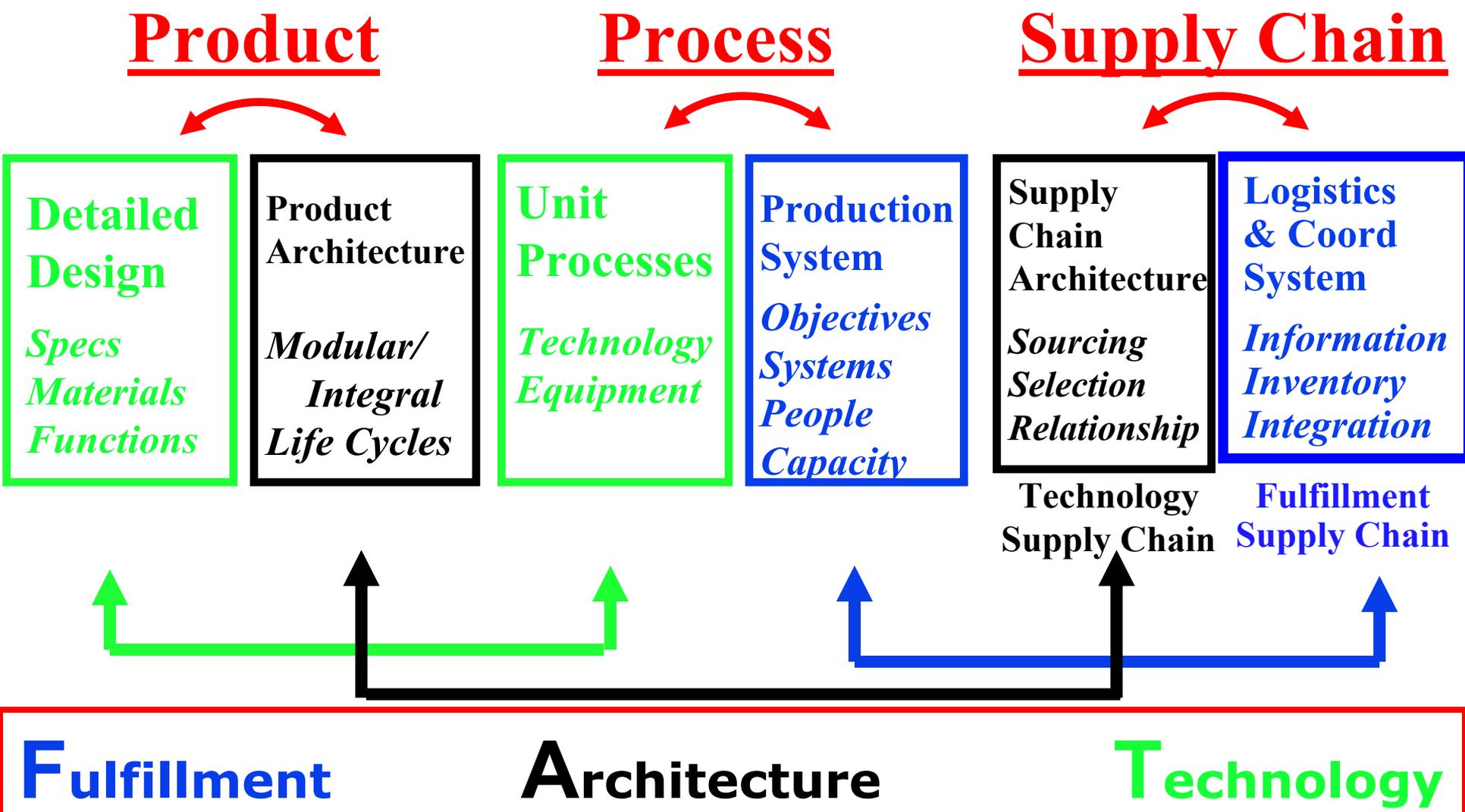# 3-D Concurrent Engineering &
the imperative of concurrency

Product

Process

Supply Chain

Detailed Design

Specs Materials Functions

Product Architecture

Modular/ Integral Life Cycles

Unit Processes

Technology Equipment

Production System

Objectives Systems People Capacity

Supply Chain Architecture

Sourcing Selection Relationship

Logistics & Coord System

Information Inventory Integration

Technology Supply Chain

Fulfillment Supply Chain

Fulfillment **Architecture** **Technology**

SC Principles to Understand

Supply Chain Focus / Decision Scope	Fulfillment Supply Chain	Technology Supply Chain
Tactical	Costs, Cycle Times, Inventories	Collaborative Prod Devel
Strategic	Bullwhip Revenue Management IT System Design Order Fulfill. Process Logistics System Design Supply-Demand balance Relationship Design Flexibility	Clockspeed Double Helix Supply Chain Architecture Value Migration 3-DCE

Components of Supply Chain Business Processes

System Design/Capabilities

Product   **Fulfillment**

Process   **Architecture**

Supply Chain   **Technology**

External Influences

-clockspeeds (product, process)

-risks (design, supply, demand)

Solution Implementation

-postponement

-quick response

-lean production

-common parts/
**   platforms**

Operational Objectives/Customer Requirements

-cost

-quality

-speed (flexibility, responsiveness)

-improvement (learning/knowledge)

INTRODUCTIONS

Who are you?

What can you offer?

What do you want to learn?

Strategic Supply Chain Design

1. **Fruit Flies & Supply Chain Evolution**

2. **Supply Chain Design & 3-DCE**

3. **Customer Service and Service Supply Chains**

4. **Value Chain Roadmapping & Strategy Making**

Supply Chain Design in a **Fast-Clockspeed** World: Study the **Industry Fruitflies**

---

*Evolution in
the natural world:*

FRUITFLIES
evolve faster than
MAMMALS
evolve faster than
REPTILES

THE KEY TOOL:

*Cross-SPECIES
Benchmarking
of Dynamic Forces*

---

*Evolution in
the industrial world:*

INFOTAINMENT is faster than
MICROCHIPS is faster than
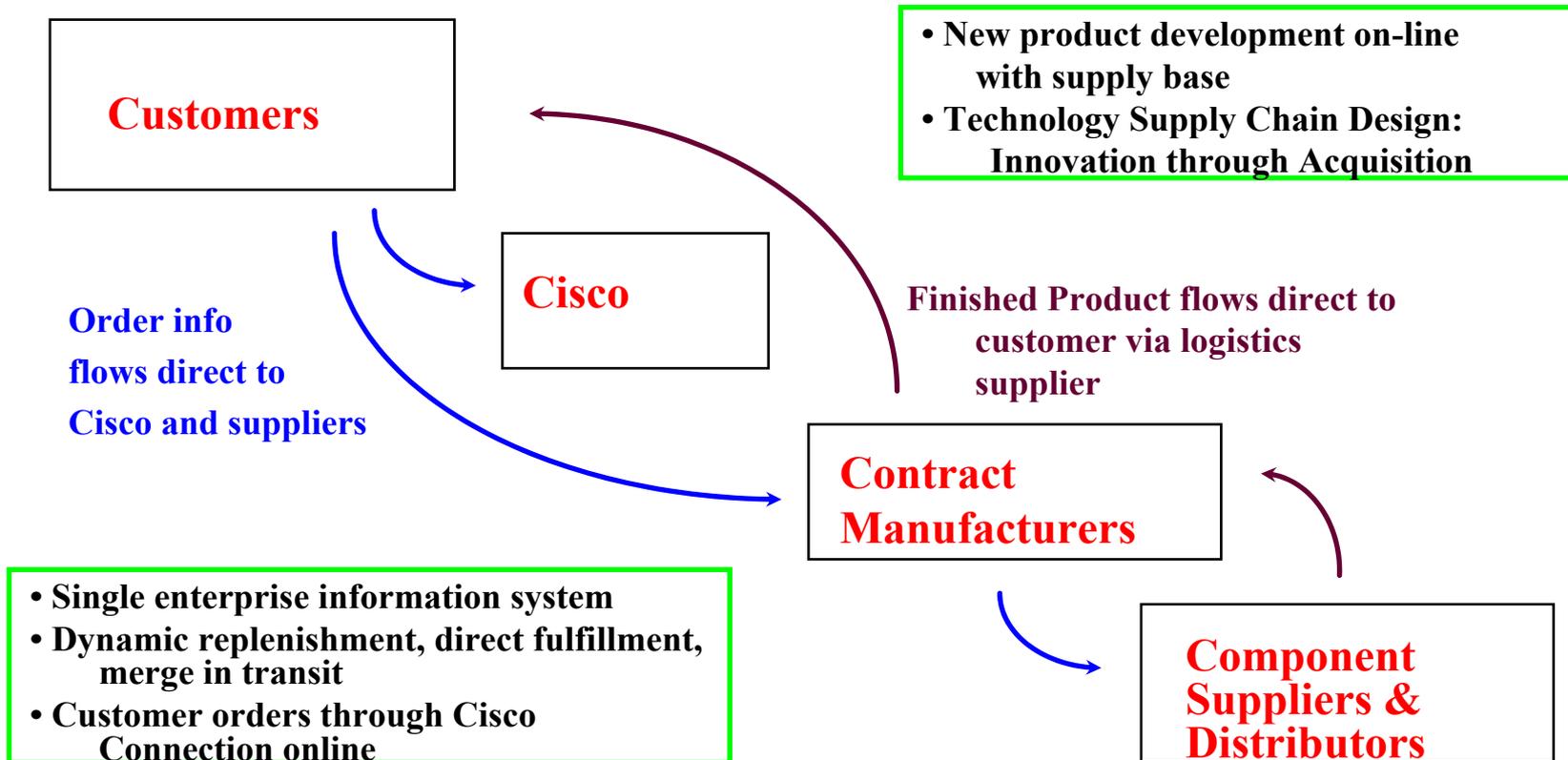**AUTOS** evolve faster than
AIRCRAFT evolve faster than
MINERAL EXTRACTION

THE KEY TOOL:

*Cross-INDUSTRY
Benchmarking
of Dynamic Forces*

Cisco's End-to-End Integration for its Fulfillment Supply Chain

Customers

Cisco

- New product development on-line with supply base
- Technology Supply Chain Design: Innovation through Acquisition

Order info flows direct to Cisco and suppliers

Finished Product flows direct to customer via logistics supplier

Contract Manufacturers

- Single enterprise information system
- Dynamic replenishment, direct fulfillment, merge in transit
- Customer orders through Cisco Connection online

Component Suppliers & Distributors

Basic Design Principle: Arm's length Relationship with Fulfillment Chain Partners

Cisco's Strategy for Technology Supply Chain Design

1. Integrate technology around the router to be a communications network provider.
2. Leverage acquired technology with
   - sales muscle and reach
   - end-to-end IT
   - outsourced manufacturing
   - market growth
3. Leverage venture capital to supply R&D

Basic Design Principle: Acquisition Relationship with Technology Chain Partners

Volatility Amplification in the Supply Chain:
"The Bullwhip Effect"
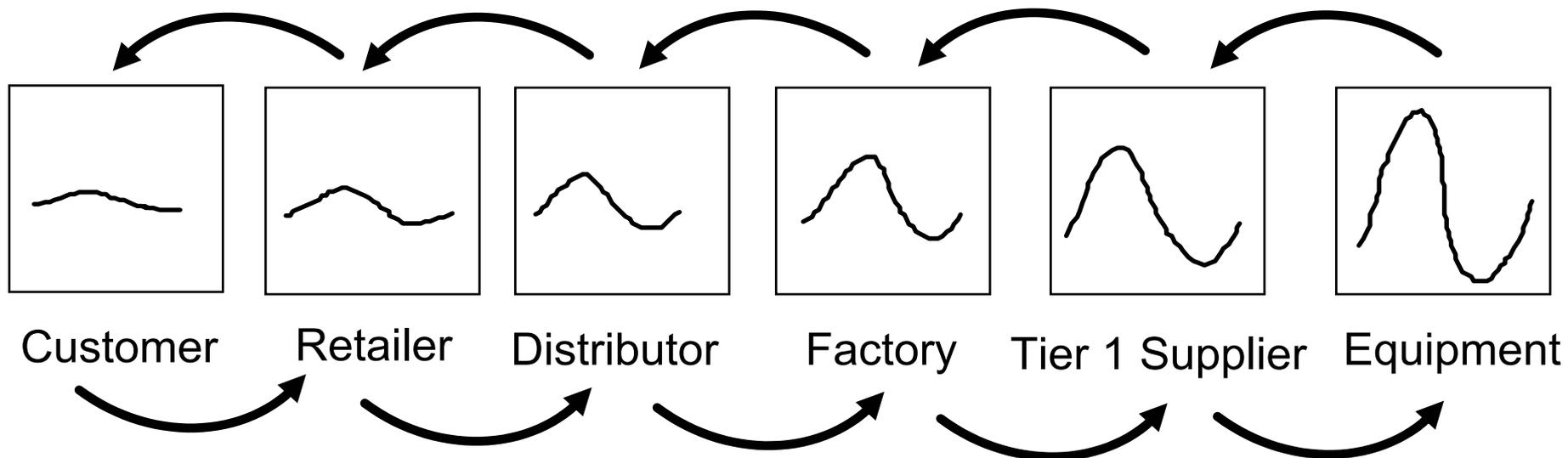
Customer   Retailer   Distributor   Factory   Tier 1 Supplier   Equipment

Information lags
Delivery lags
Over- and underordering
Misperceptions of feedback
Lumpiness in ordering
Chain accumulations

SOLUTIONS:
Countercyclical Markets
Countercyclical Technologies
Collaborative channel mgmt.
(Cincinnati Milacron & Boeing)

Supply Chain Volatility Amplification:
Machine Tools at the tip of the Bullwhip
- - -

"We are experiencing a 100-year flood." J. Chambers, 4/16/01

See "Upstream Volatility in the Supply Chain: The Machine Tool Industry as a Case Study,"
E. Anderson, C. Fine & G. Parker *Production and Operations Management,*
Vol. 9, No. 3, Fall 2000, pp. 239-261.

LESSONS FROM A FRUIT FLY:
CISCO SYSTEMS

1. KNOW YOUR LOCATION IN THE VALUE CHAIN
2. UNDERSTAND THE DYNAMICS
    OF VALUE CHAIN FLUCTUATIONS
3. THINK CAREFULLY ABOUT THE ROLE
    OF VERTICAL COLLABORATIVE RELATIONSHIPS
4. INFORMATION AND LOGISTICS SPEED DO NOT
    REPEAL BUSINESS CYCLES OR THE BULLWHIP.

Bonus Question:
How does clockspeed impact volatility?

INDUSTRY CLOCKSPEED IS A COMPOSITE:
OF PRODUCT, PROCESS, AND ORGANIZATIONAL CLOCKSPEEDS

Mobile Phone **INDUSTRY CLOCKSPEED**

THE
Mobile Phone
product technology

THE
Mobile Phone
PRODUCTION PROCESS
process technology

THE
Mobile Phone
**MANUFACTURING COMPANY**
organization

Mobile Phone System CLOCKSPEED is a mix of Transmission Standards, Software and Handsets

Mobile Phone System

TRANSMISSION STANDARD
slow clockspeed

OPERATING SYSTEM
slow clockspeed

SOFTWARE APPLICATIONS
medium clockspeed

SERVICES
fast clockspeed

HAND SET
fast clockspeed
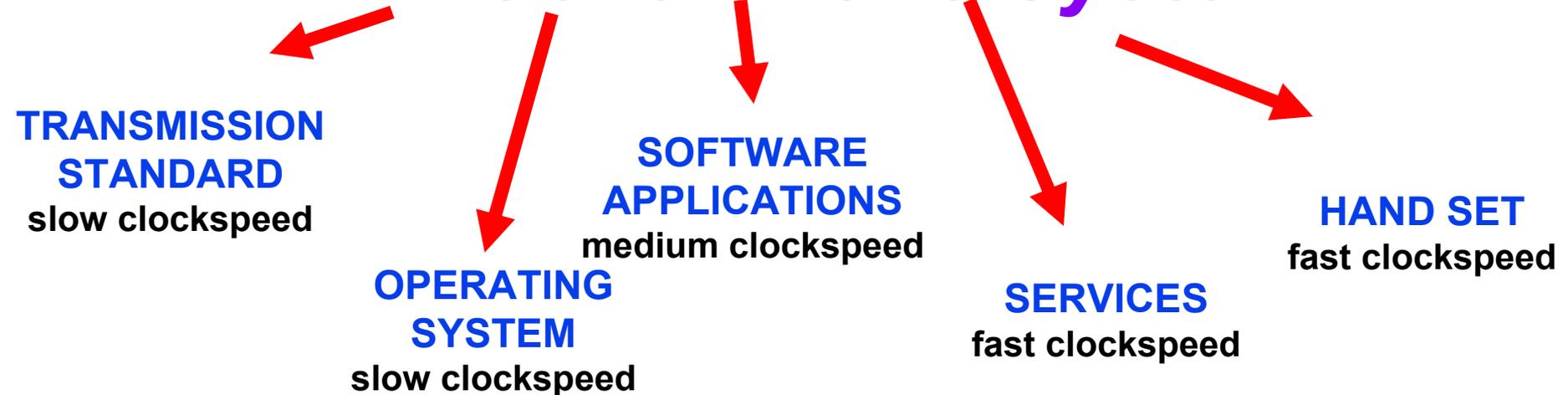
ISSUE: THE FIRMS THAT ARE FORCED TO RUN AT THE FASTEST CLOCKSPEED ARE THE MOST LIKELY TO STAY AHEAD OF THE GAME.

# *Automobile* CLOCKSPEED IS A MIX OF ENGINE, BODY & ELECTRONICS

Automobile

ENGINE
slow clockspeed

BODY
medium clockspeed

ELECTRONICS
fast clockspeed
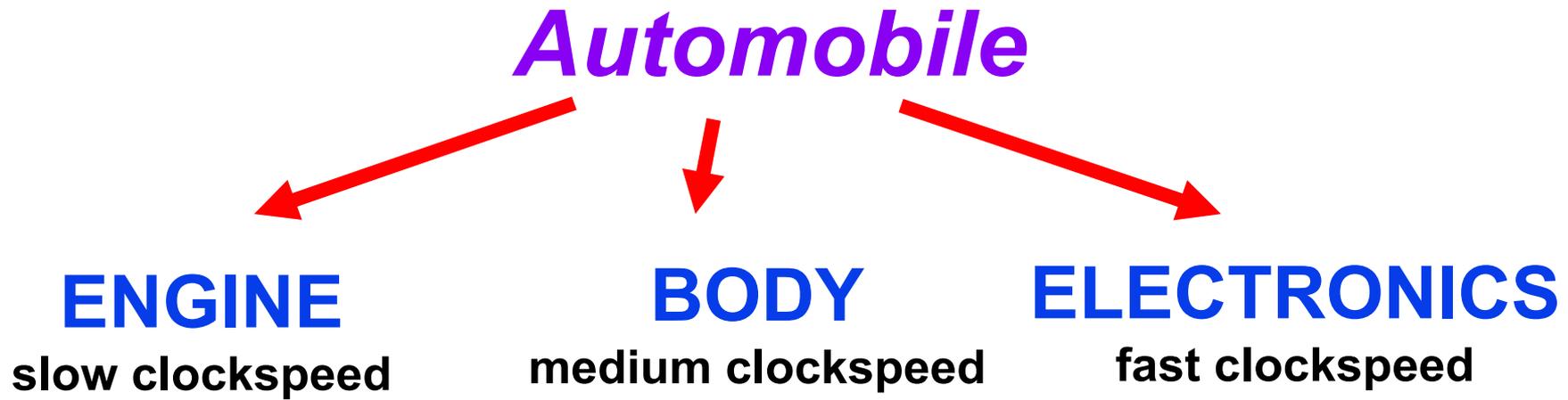
ISSUE: MOST AUTO FIRMS OPERATE AT *ENGINE OR BODY CLOCKSPEEDS*; IN THE FUTURE THEY WILL NEED TO RUN AT *ELECTRONICS CLOCKSPEED.*
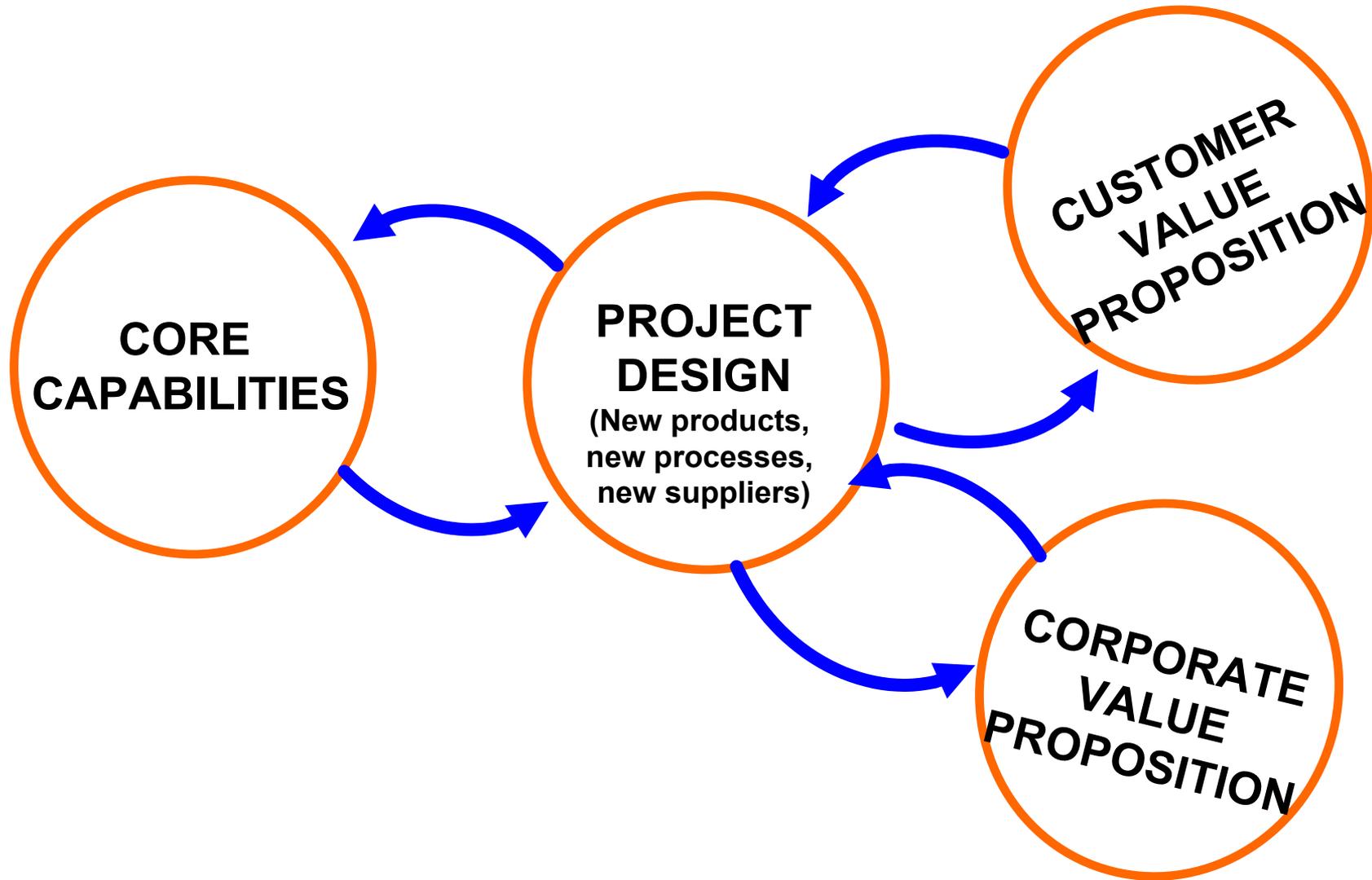
Clockspeed drives
Business Strategy Cadence

Dynamics between New Projects and Core Capability Development: PROJECTS MUST MAKE MONEY AND BUILD CAPABILITIES

CORE CAPABILITIES

NEW PROJECTS
(New products, new processes, new suppliers)
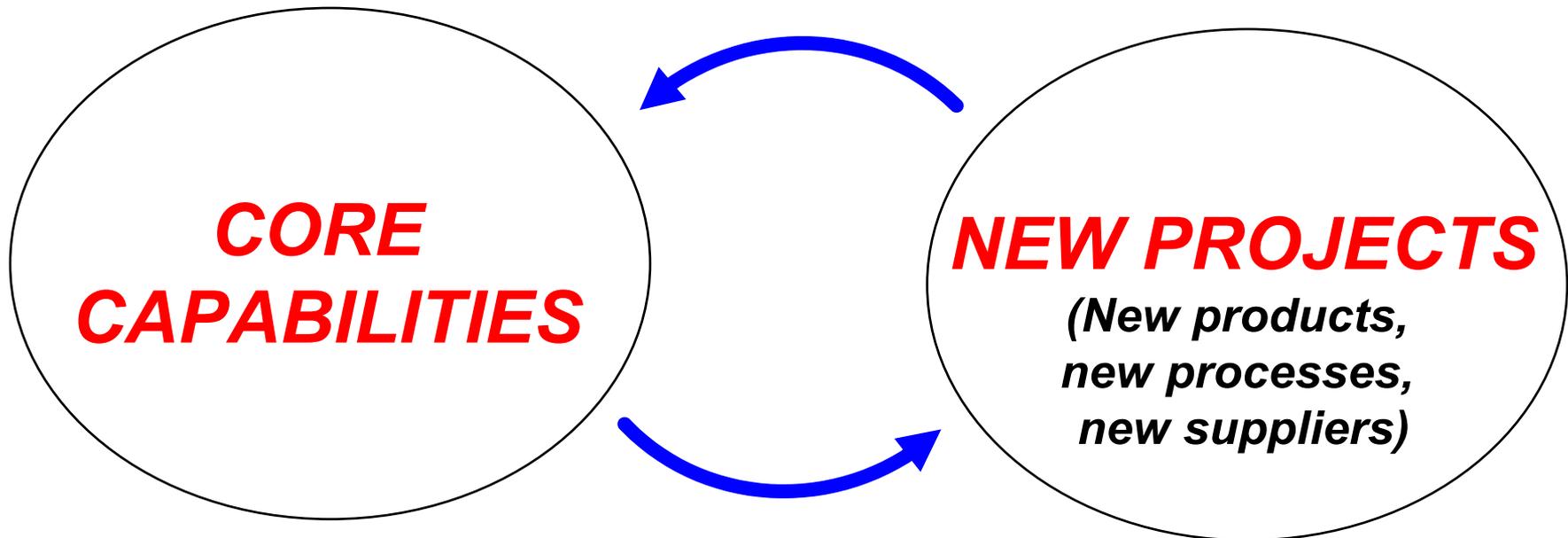
See Leonard-Barton, D. *Wellsprings of Knowledge*

Projects Serve Three Masters:
Capabilities, Customers, & Corporate Profit

CORE CAPABILITIES

PROJECT DESIGN
(New products, new processes, new suppliers)

CUSTOMER VALUE PROPOSITION

CORPORATE VALUE PROPOSITION

The Strategic Leverage of Value Chain Design:
Who let Intel Inside?

1980: IBM designs a product, a process, & a value chain

Customers

IBM

Intel Inside

Intel

Microsoft
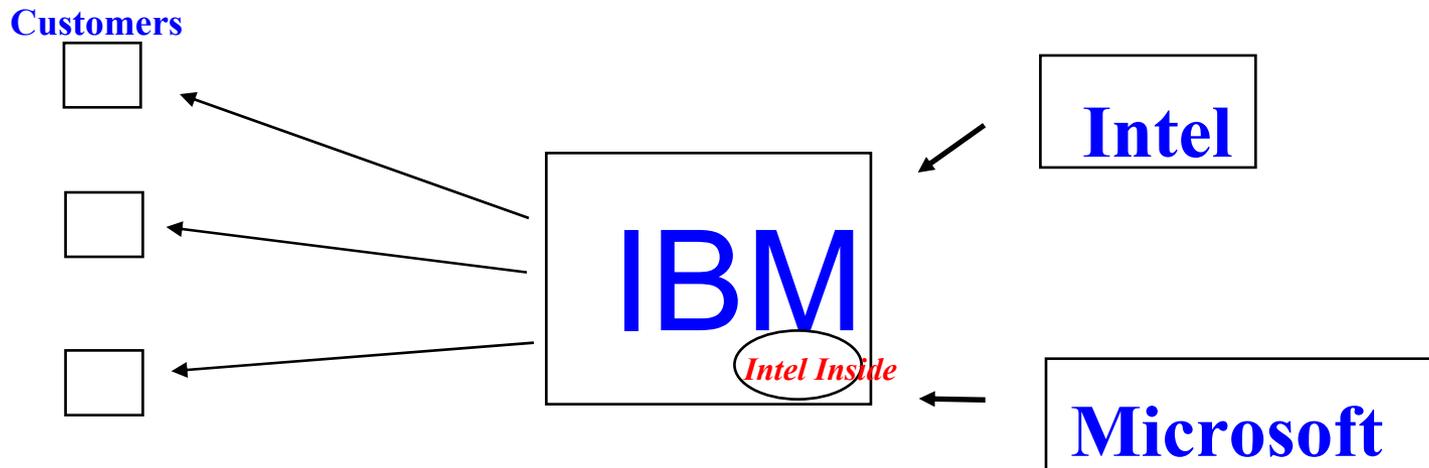
The Outcome:

    A phenomenonally successful product design
    A disastrous value chain design (for IBM)

LESSONS FROM A FRUIT FLY:
THE PERSONAL COMPUTER

1. BEWARE OF *INTEL INSIDE*
   (Regardless of your industry)

2. MAKE/BUY IS **NOT** ABOUT WHETHER IT IS
   TWO CENTS CHEAPER TO OUTSOURCE

3. VALUE CHAIN DESIGN CAN DETERMINE
   THE FATE OF **COMPANIES** AND **INDUSTRIES**,
   AND OF **PROFIT** AND **POWER**

4. THE LOCUS OF VALUE CHAIN CONTROL
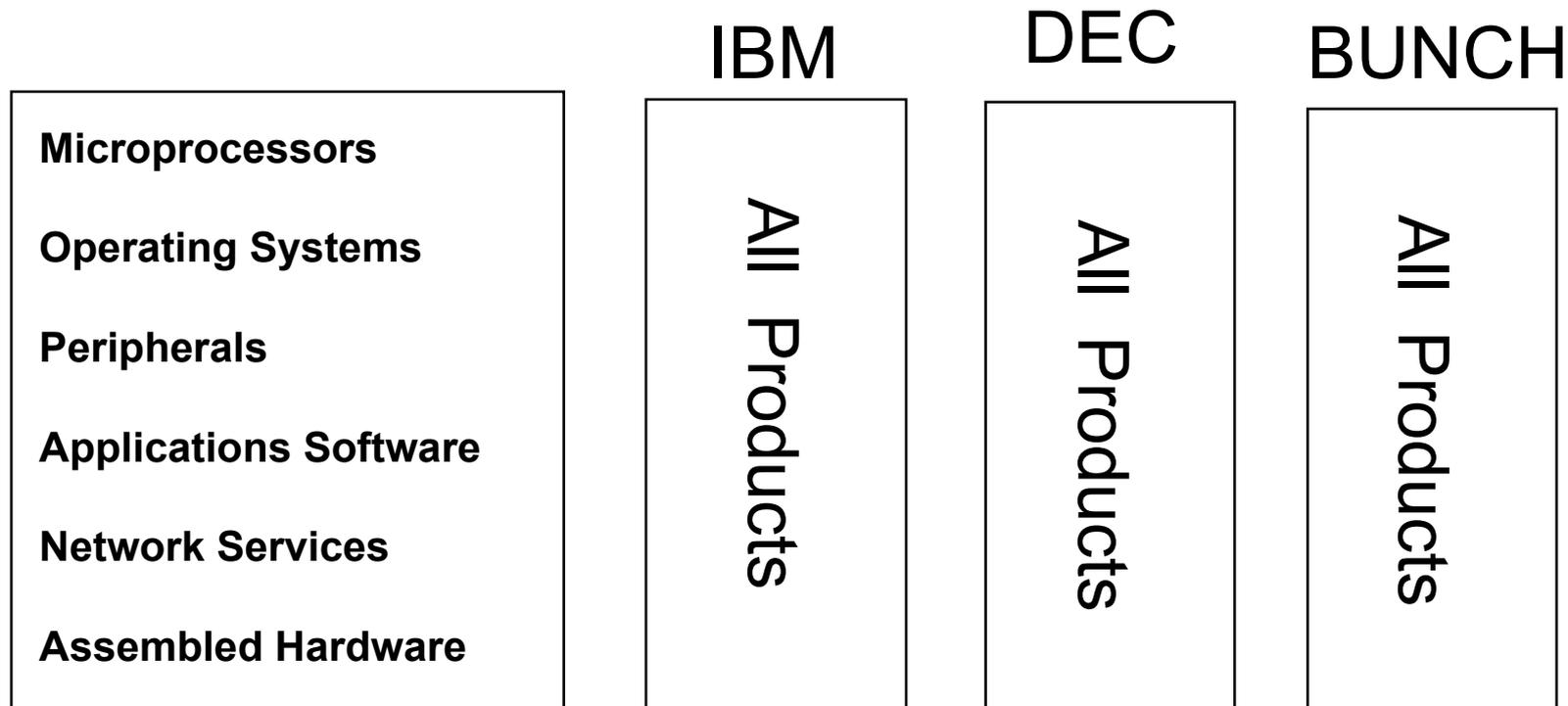   CAN SHIFT IN **UNPREDICTABLE** WAYS

LESSONS FROM A FRUIT FLY:
THE PERSONAL COMPUTER

1. BEWARE OF *INTEL INSIDE*
   (Regardless of your industry)

2. MAKE/BUY IS **NOT** ABOUT WHETHER IT IS
   TWO CENTS CHEAPER OR *TWO DAYS FASTER*
   TO OUTSOURCE VERSUS INSOURCE.

3. DEVELOPMENT PARTNERSHIP DESIGN CAN
   DETERMINE THE FATE OF COMPANIES AND
   INDUSTRIES, AND OF PROFIT AND POWER

4. THE LOCUS OF VALUE CHAIN CONTROL
   CAN SHIFT IN UNPREDICTABLE WAYS

Vertical Industry Structure with *Integral* Product Architecture

Computer Industry Structure, 1975-85

	IBM	DEC	BUNCH
Microprocessors Operating Systems Peripherals Applications Software Network Services Assembled Hardware	All Products	All Products	All Products

(See A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

Horizontal Industry Structure
with *Modular* Product Architecture

Computer Industry Structure, 1985-95

Microprocessors	Intel · **Moto** · **AMD** · etc
Operating Systems	Microsoft · Mac · Unix
Peripherals	HP · Epson · Seagate · etc · etc
Applications Software	Microsoft · Lotus · Novell · etc
Network Services	AOL/Netscape · Microsoft · EDS · etc
Assembled Hardware	HP · Compaq · IBM · Dell · etc

(See A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

THE DYNAMICS OF PRODUCT ARCHITECTURE AND VALUE CHAIN STRUCTURE:
THE DOUBLE HELIX

See Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

THE *DOUBLE HELIX* IN OTHER INDUSTRIES

- *TELECOMMUNICATIONS--*
  - "MA BELL" was Vertical /Integral
  - BABY BELLS & LONG LINES & CELLULAR are Horizontal/Modular
  - Today's Verizon is going back to Vertical /Integral

- *AUTOMOTIVE--*
  - Detroit in the 1890's was Horizontal/Modular
  - Ford & GM in the mid 1900's were Vertical /Integral
  - Today's Auto Industry is going back to Horizontal/Modular

- *TELEVISION--*
  - RCA was Vertical /Integral
  - 1970'S THROUGH 1990'S were Horizontal/Modular
  - Today's media giants are going back to Vertical /Integral

- *BICYCLES--*
  - Safety Bikes to 1890's boom to Schwinn to *Shimano Inside*

Controlling the Chain Through Distribution:
## The End of *P&G Inside* ?

- *Controlling the Channel Through Closeness to Customers:*
- *consumer research, pricing, promotion, product development*

Customers
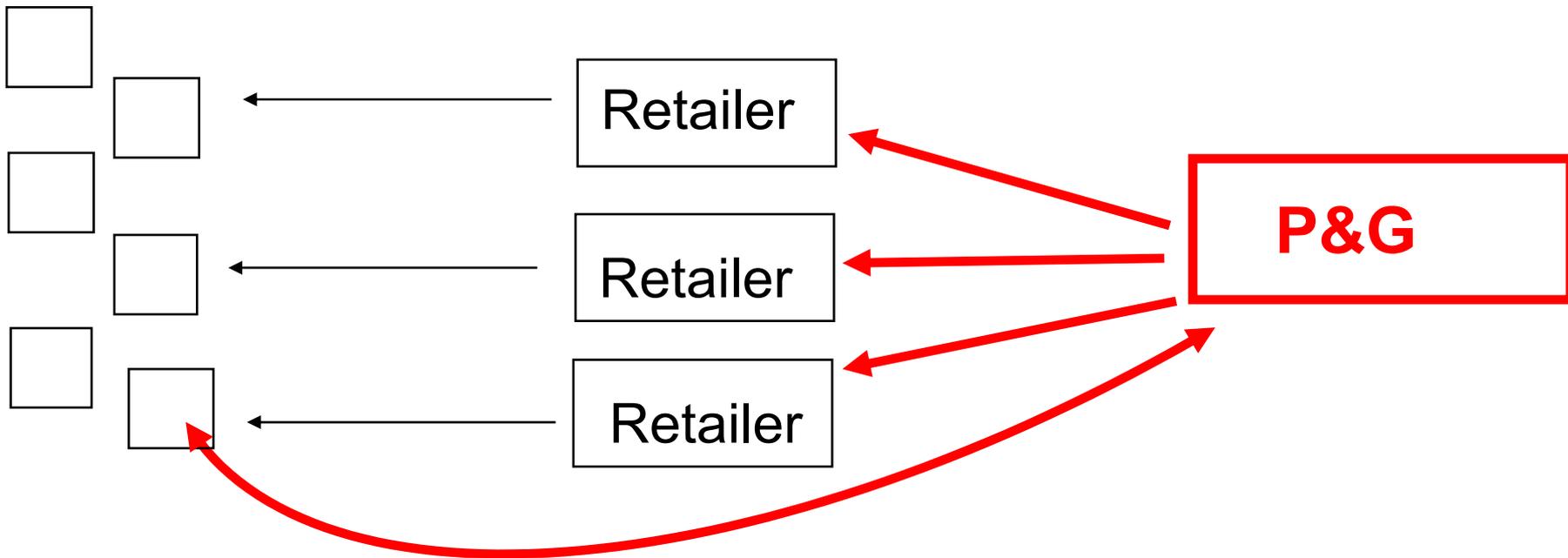
# Controlling the Chain Through Distribution:
Beware of *Walmart Outside*

Controlling the Channel Through Closeness to Customers: Chain Proximity

Customers

WalMart

Retailer

Retailer

Retailer
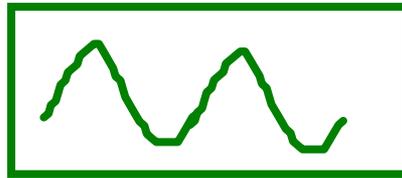
P&G

WalMart Private Label
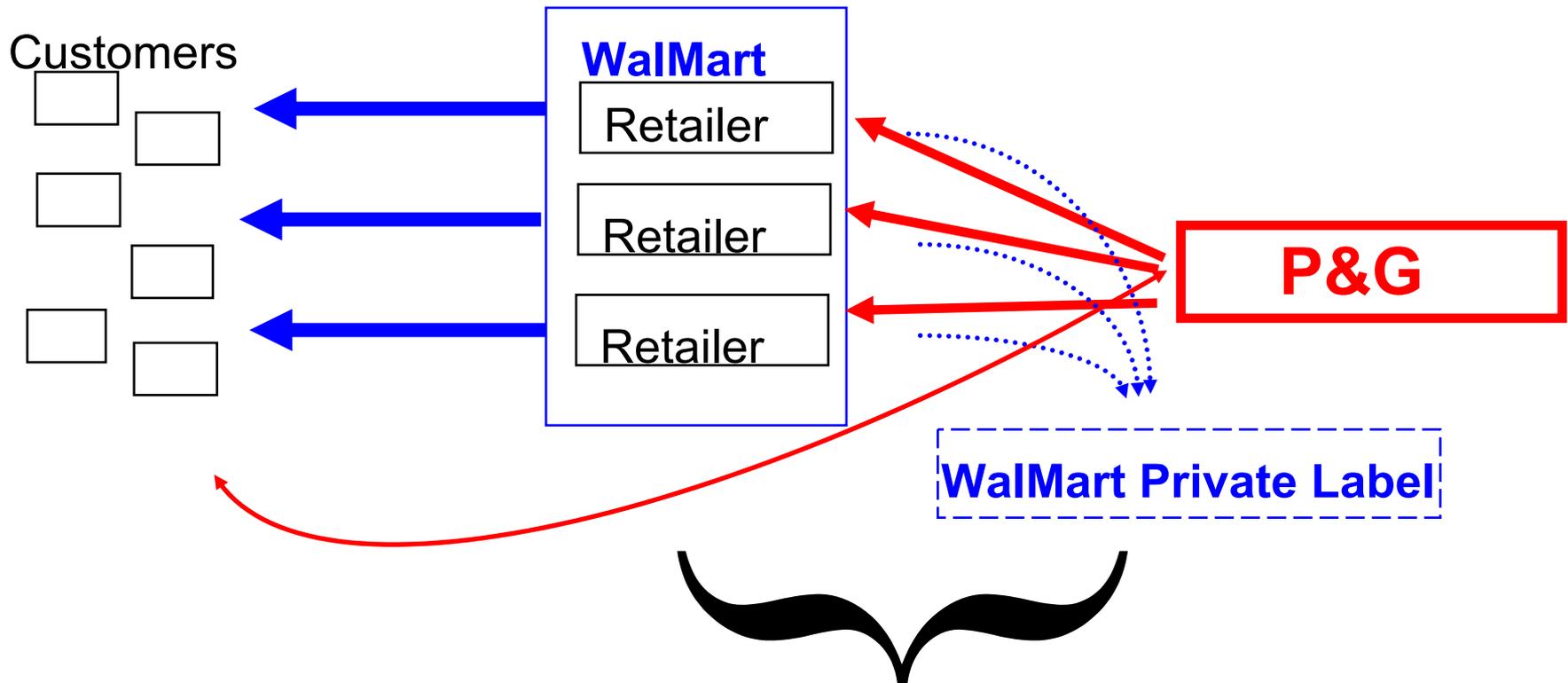
Vertical Growth on the Double Helix

Clockspeeds accelerate as you head downstream, closer to the final customer ;
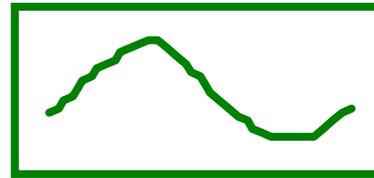
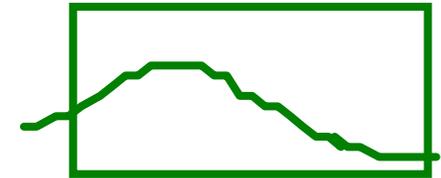**Clockspeed = f(technology push, customer pull, system complexity)**
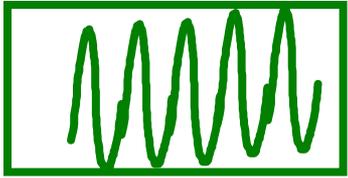
| **New Phone Applications** | **Handset Platforms** | **Telecom Equipment** | **Optical Components** |

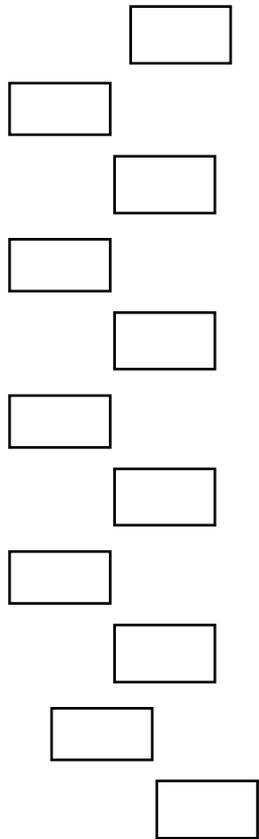| **Web Site Developer** | **PC Maker** | **Chip maker** | **Semiconductor Equipment Maker** |

| **In-Vehicle Services** | **Automobile** | **Telematics System** | **Vehicle Electronics Architecture** |

Media Supply Chains: An Industry at *Lightspeed*

Customers	The box	The Pipe (Access, Metro, Backbone)	The Content

Customers

The box

Wired Phone

Wireless phone

PC/laptop

PDA

Television

VCR

Pager

The Pipe
(Access, Metro, Backbone)

Land-basedTelco:
-copper POTS
-fiber
-DSL

Cable Networks

Wireless:
-broadcast TV
-CDMA, TDMA, GSM
-satellite/microwave

Retail Outlets
-Borders:
-Blockbuster
-Seven-Eleven

Delivery (e.g., Fedex)

The Content

Video/Audio:

Movies & Art
& News & Sports

News/articles/books
(newspapers &
magazines)

Communication:
voice & video & email

Banking

Education

Shopping

Internet, *et al*

ALL COMPETITIVE ADVANTAGE IS TEMPORARY

Autos:
Ford in 1920, *GM* in 1955, *Toyota* in 1990

Computing:
***IBM* in 1970, *DEC* in 1980, *Wintel* in 1990**

World Dominion:
***Greece* in 500 BC, *Rome* in 100AD, *G.B.* in 1800**

Sports:
***Bruins* in 1971, *Celtics* in 1986, *Yankees* no end**

The faster the clockspeed, the shorter the reign

Exercise 1:
Value Chain Analysis

Consider these five industries:

  -Food

  -Defense aircraft

  -Automobiles

  -Handheld electronic organizers/communicators

  -Music

At each table, pick two of these industries:

 What are the key elements in the value chain?

 Who has power in the chain?

 What are the key dynamic processes influencing chain power?

Strategic Supply Chain Design

1. **Fruit Flies & Supply Chain Evolution**

2. **Supply Chain Design & 3-DCE**

3. **Customer Service and Service Supply Chains**

4. **Value Chain Roadmapping & Strategy Making**

VALUE CHAIN DESIGN:
Three Components

1. Insourcing/OutSourcing
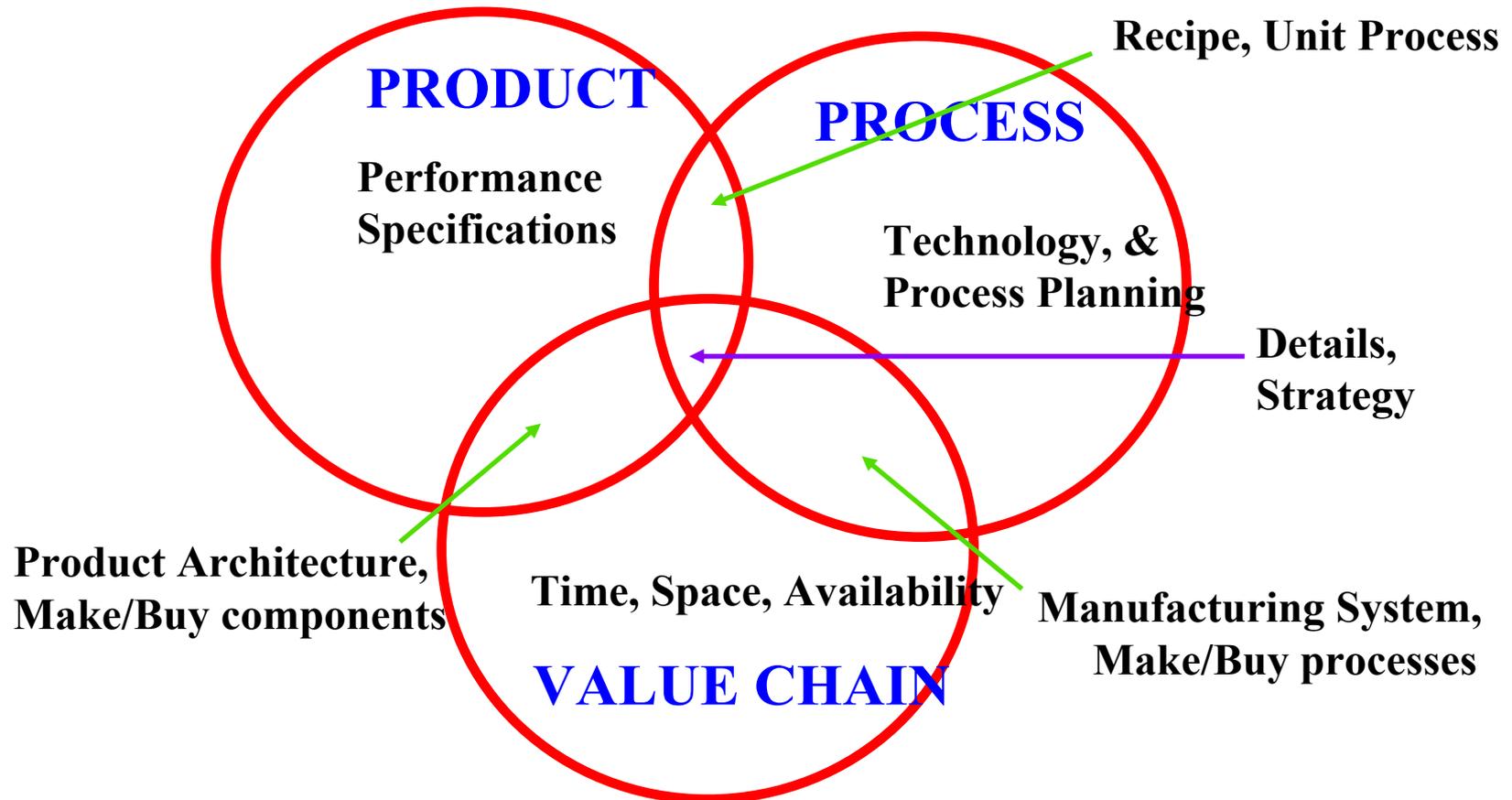*(The Make/Buy or Vertical Integration Decision)*

2. Partner Selection
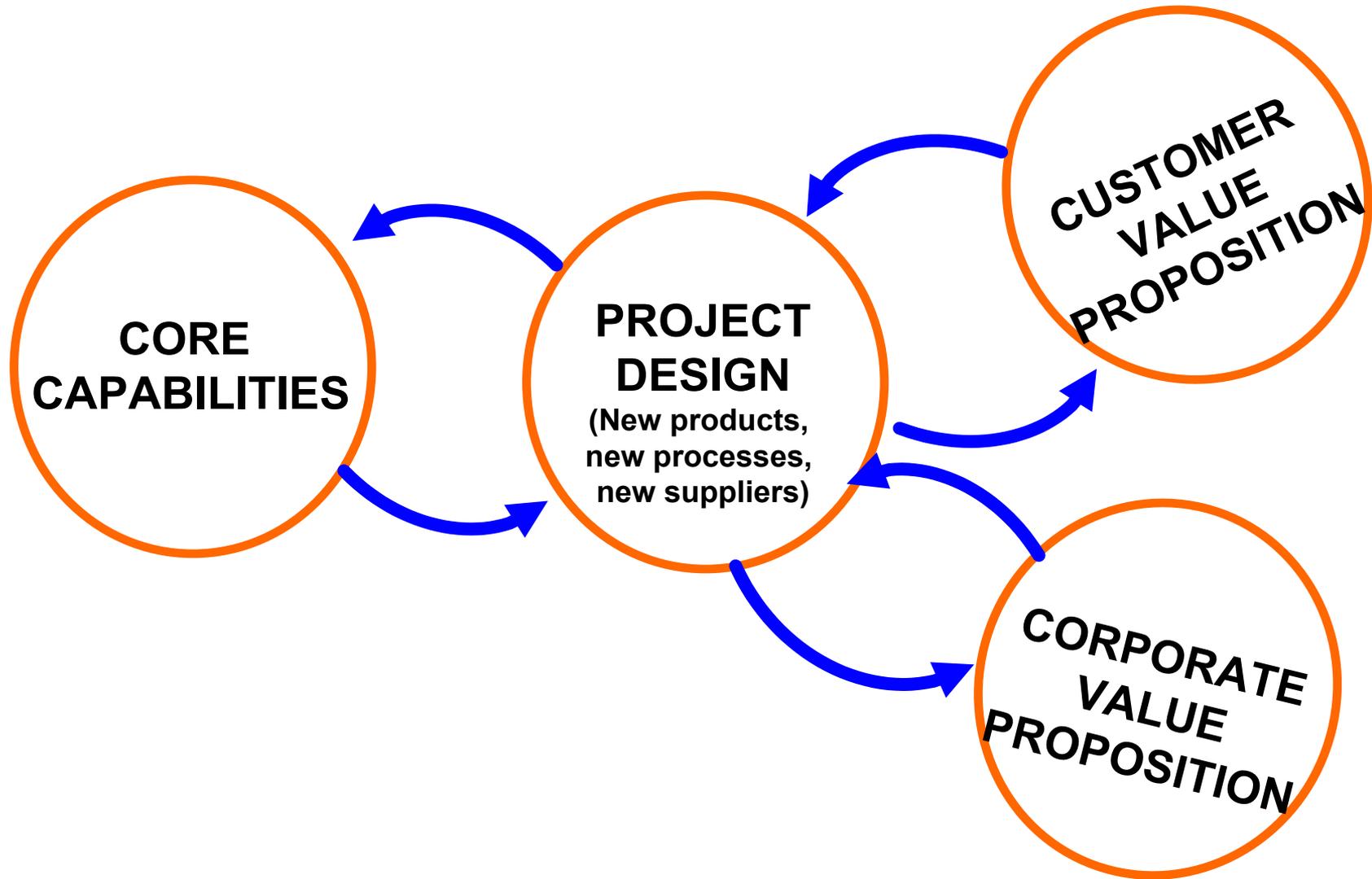*(Choice of suppliers and partners for the chain)*

3. The Contractual Relationship
(Arm's length, joint venture, long-term contract, strategic alliance, equity participation, etc.)

IMPLEMENTATION OF VALUE CHAIN DESIGN: EMBED IT IN 3-D CONCURRENT ENGINEERING

PRODUCT

PROCESS

Recipe, Unit Process

Performance Specifications

Technology, & Process Planning

Details, Strategy

Product Architecture, Make/Buy components

Time, Space, Availability

Manufacturing System, Make/Buy processes

VALUE CHAIN

Projects Serve Three Masters: Capabilities, Customers, & Corporate Profit

IMPLEMENTATION OF *PROJECT DESIGN:*
FRAME IT AS 3-D CONCURRENT ENGINEERING
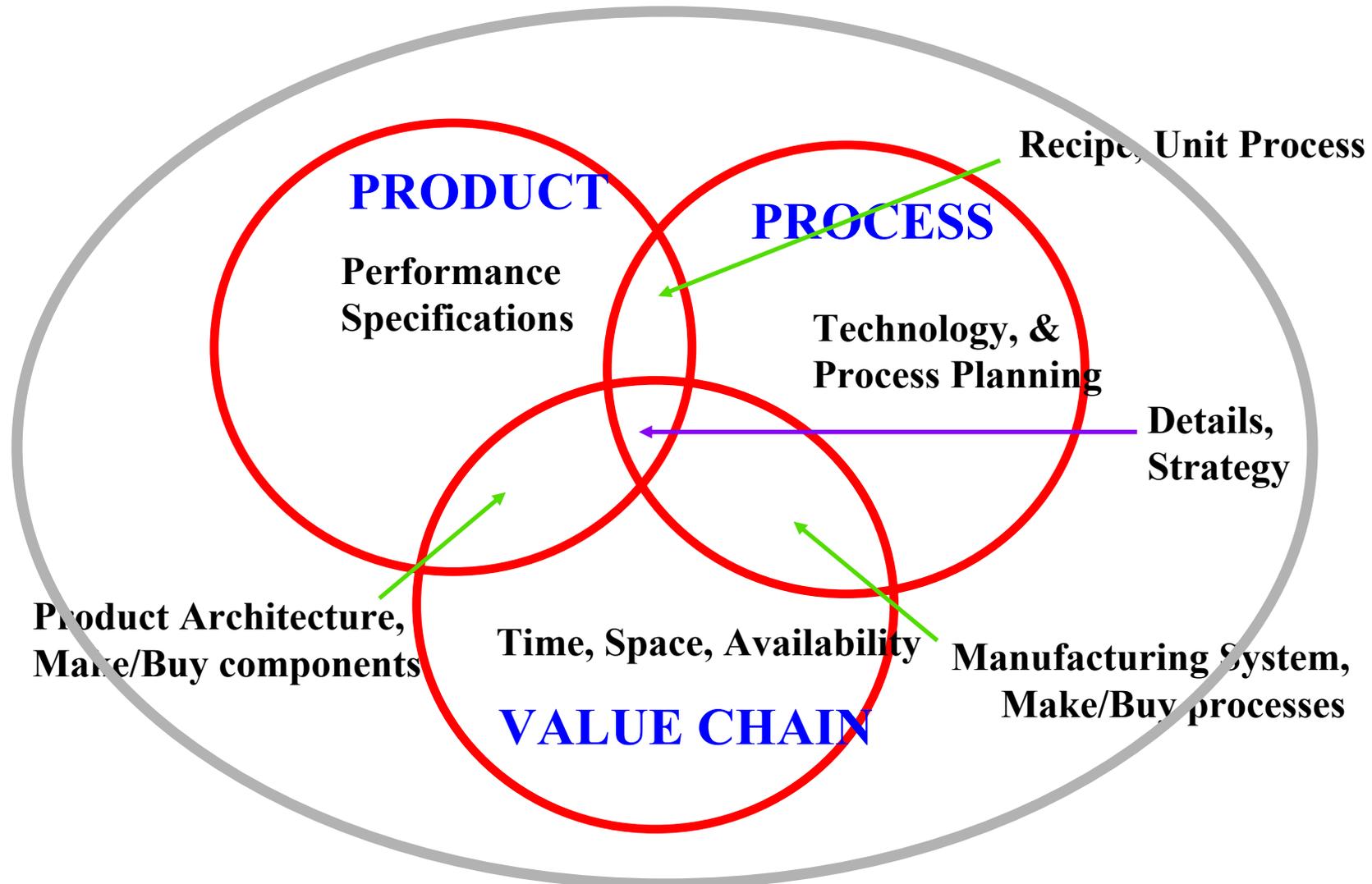
ARCHITECTURES IN 3-D
INTEGRALITY VS. *MODULARITY*

Integral product architectures **feature**
  close coupling among the elements
- **Elements perform many functions**
- **Elements are in close spacial proximity**
- **Elements are tightly synchronized**

- **Ex: jet engine, airplane wing, microprocessor**

Modular product architectures **feature**
  separation among the elements
- **Elements are interchangeable**
- **Elements are individually upgradeable**
- **Element interfaces are standardized**
- **System failures can be localized**

- **Ex: stereo system, desktop PC, bicycle**

VALUE CHAIN ARCHITECTURE

Integral value-chain architecture
features close proximity among its elements
- **Proximity metrics: Geographic, Organizational**
Cultural, Electronic
- **Example: Toyota city**
- **Example: Ma Bell (AT&T in New Jersey)**
- **Example: IBM mainframes & Hudson River Valley**

Modular value-chain architecture features multiple,
interchangeable supplier and standard interfaces
- **Example: Garment industry**
- **Example: PC industry**
- **Example: General Motors' global sourcing**
- **Example: Telephones and telephone service**

ALIGNING ARCHITECTURES: BUSINESS SYSTEMS & TECHNOLOGICAL SYSTEMS

BUSINESS SYSTEM/SUPPLY CHAIN ARCHITECTURE
(Geog., Organ., Cultural, Elec.)

TECHNOLOGY/PRODUCT ARCHITECTURE

	INTEGRAL ⟷		MODULAR
INTEGRAL	Microprocessors Mercedes & BMW vehicles	Lucent Nortel	Polaroid
	MSFT Windows	Chrysler vehicles	Cisco
MODULAR	Digital Rights/ Music Distribution		Dell PC'S Bicycles

Dell Supply Chain

Global \ Regional Procurement ↔ **Demand/ Supply Management** ← **Demand Management**

Continuity of Supply

Build to customer specifications

Sales

Supplier

Supplier

SLC

Dell

Customer

Materials ordering cycle 10-180+ days

Customer fulfillment 2-5 days
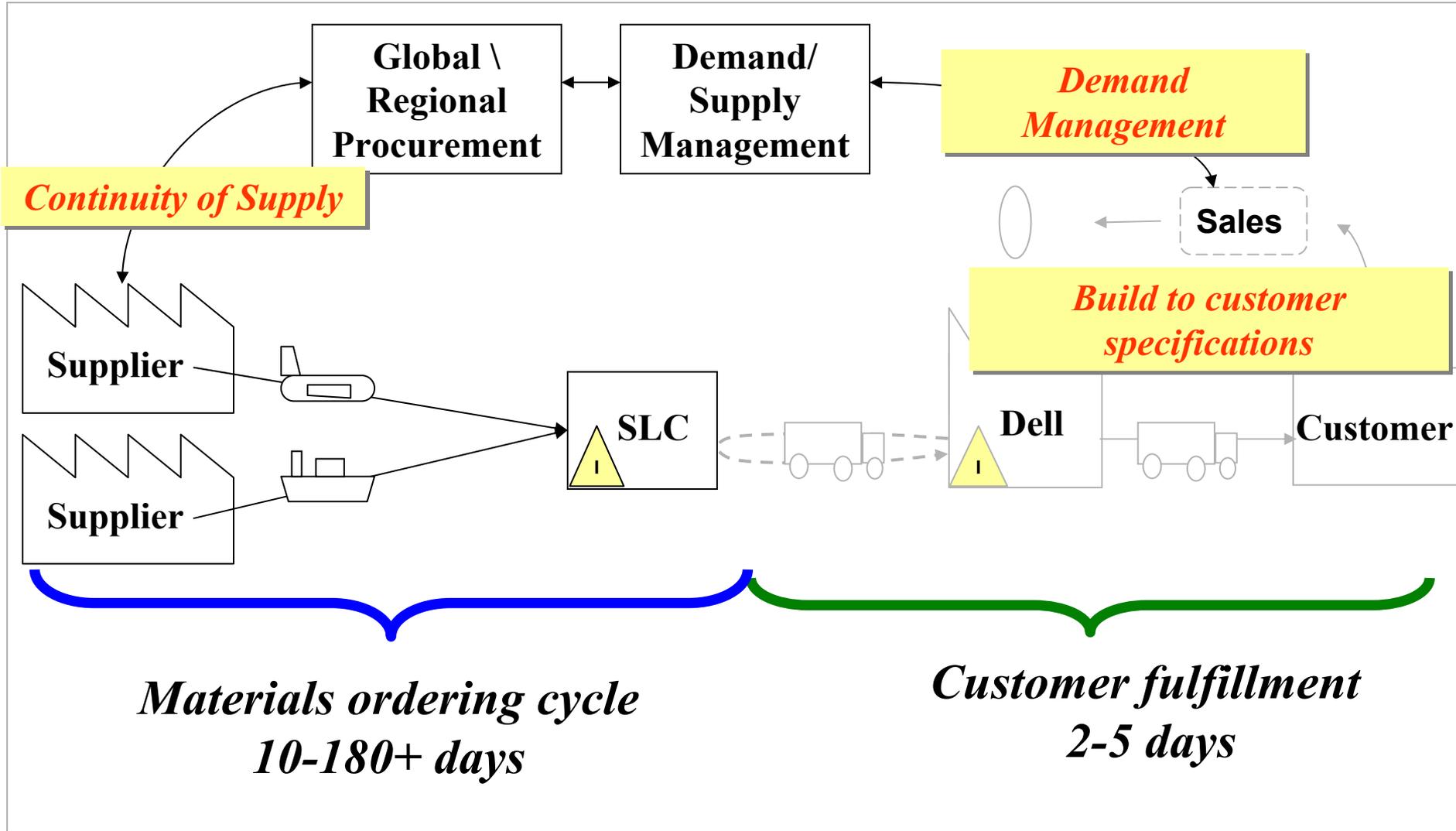
Modular Product Architecture enables Modular Supply Chain

Demand-Supply Chain Management @ Dell

- **Demand Management:**
- **Forecast = Buy = Sell**
- **Buy to Plan, but Build to Order**

- **Inventory Velocity is a wonderful thing ...**
  - <u>Customers</u> have immediate access to the latest technology.
  - <u>Suppliers</u> get their products to market quickly
  - <u>Quality</u> is improved with fewer touches.
  - <u>Cash</u> is generated through negative cash cycle.
  - Model efficiencies drive <u>Market Share</u> gain.

Can "Dell Direct" Work for Autos?

- **Appealing to OEM's on Many Dimensions**
  - **Satisfy customer need for Speed**
  - **Reduce Supply Line Inventories**
  - **Reduce mismatches and discounting**
  - **Direct OEM-Customer Relationships (& Data!)**
  - **Information Transparency**

Adapted from Prof. J.P. MacDuffie, IMVP & The Wharton School

BUT,
A Car is not a Computer!!

- ***Personal Computer***

- **~50 components**
- **8-10 key parts**
- **40 key suppliers**
- **24 hour burn-in**
- **100 design**
-     **variations**
- **Modular**
-     **Architecture**

- ***Car***

- **~ 4000 components**
- **100 key subsystems**
- **300 key suppliers**
- **12 month validation**
- **1,000,000**
-     **variations**
- **Integral**
-     **Architecture**

Adapted from Prof. J.P. MacDuffie, IMVP & The Wharton School

DESIGNING ARCHITECTURES FOR PRODUCTS & VALUE CHAINS: MODULARITY VS. OPENNESS

ARCHITECTURAL PROPRIETARINESS

ARCHITECTURAL STRUCTURE

	CLOSED	OPEN
INTEGRAL	Pentium Chip Mercedes Vehicles SAP ERP	Linux
MODULAR	IBM Mainframes Microsoft *Windows* Chrysler Vehicles	Palm Pilot software & accessories Phones & service Web-based ERP

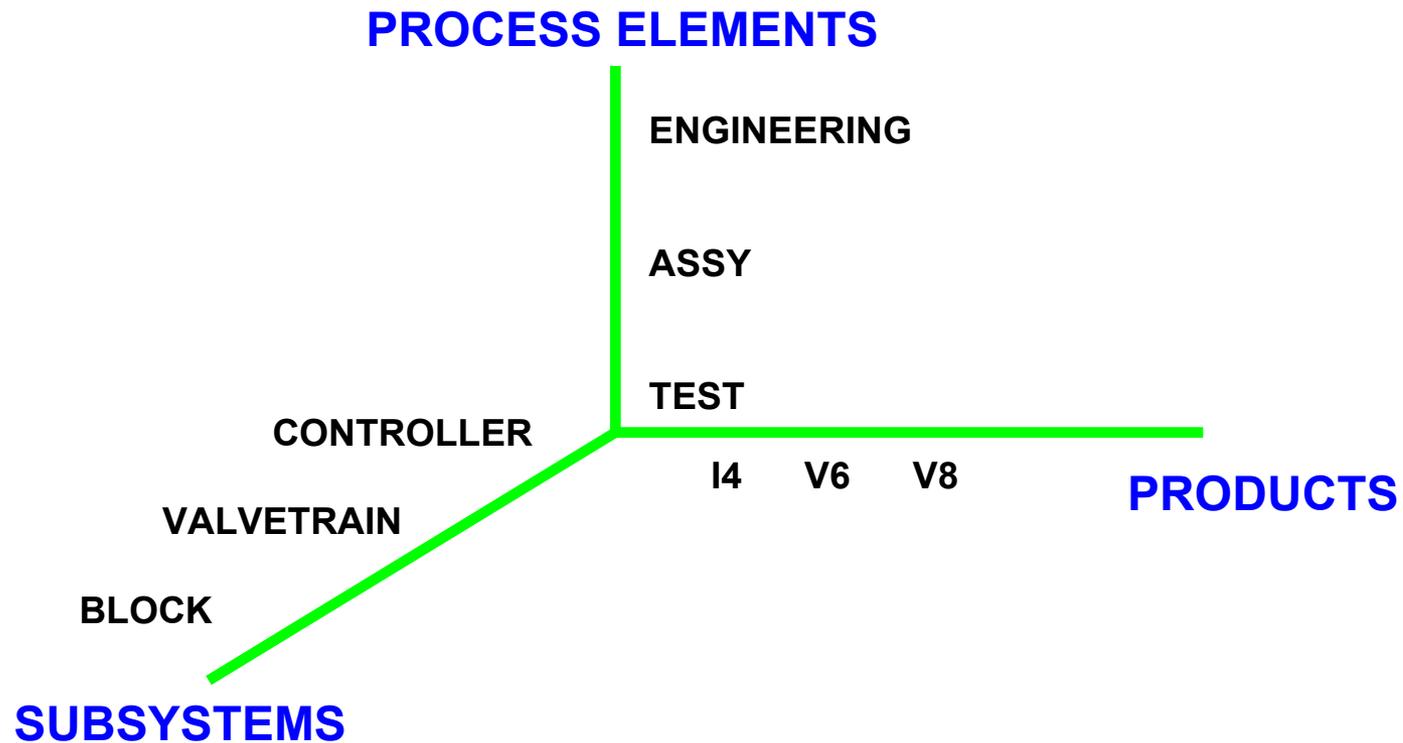## INFORMATION ARCHITECTURE MUST REFLECT BUSINESS MODEL

In/Outsourcing: Sowing the Seeds
of Competence Development to develop
dependence for knowledge or dependence for capacity

Dependence

Amount of
Work
Outsourced
knowledge
+/or supply

+ **+**

Supplier
Capability

Amount of
Supplier
Learning

+

Independence

Amount of
Work
Done In-house
knowledge
+/or supply

+ **+**

Internal
Capability

Amount of
Internal
Learning

+
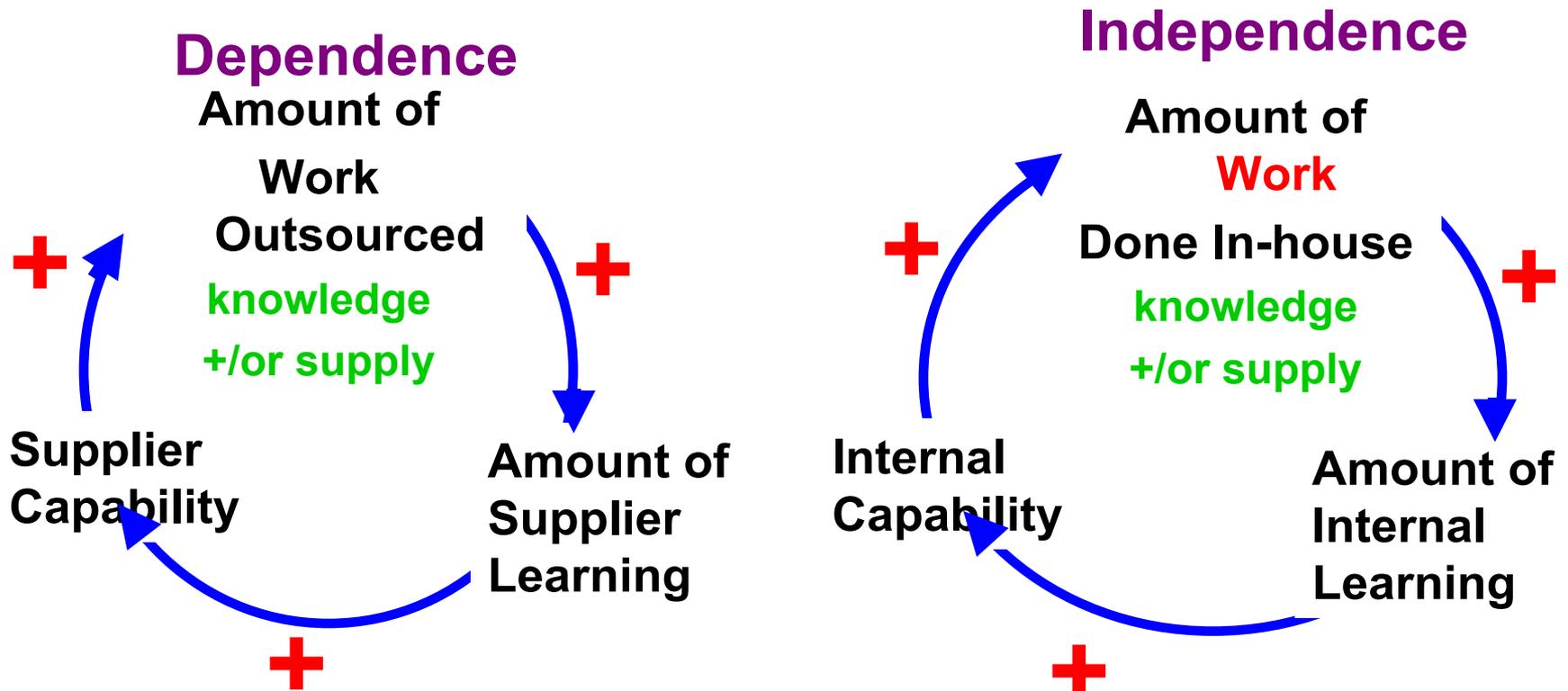
Technology Dynamics in the Aircraft Industry:
LEARNING FROM THE DINOSAURS

Japanese appeal as subcontractors

U.S. firms' appeal as subcontractors

Japanese Industry Autonomy

Boeing outsources to Japan
(Mitsubishi Inside?)

Japanese industry size & capability

U.S. industry size & capability

+ + + + + + −

SOURCEABLE ELEMENTS

PROCESS ELEMENTS

ENGINEERING

ASSY

TEST

CONTROLLER

VALVETRAIN

BLOCK

I4   V6   V8
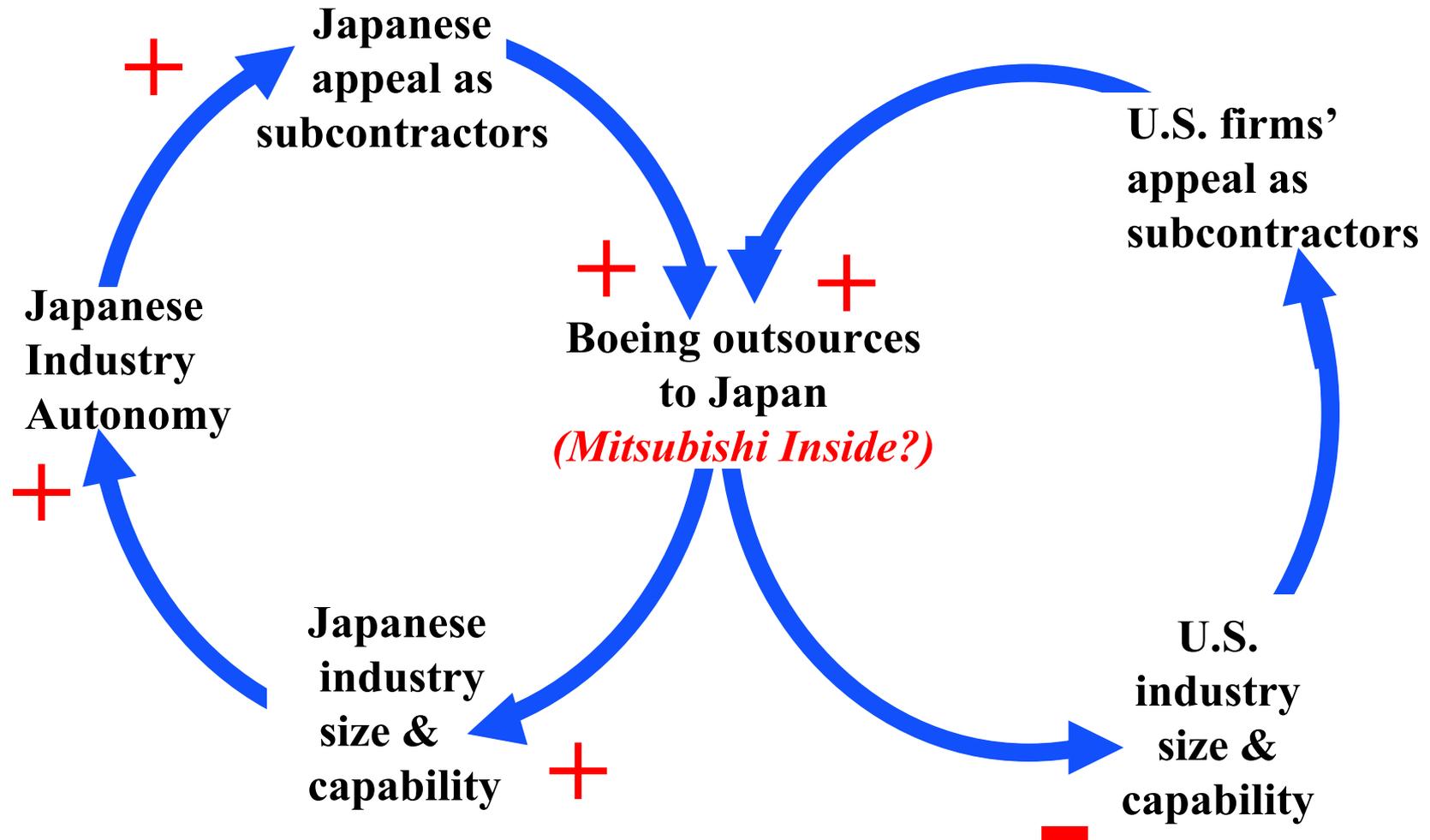
PRODUCTS

SUBSYSTEMS

Strategic Make/Buy Decisions:
Assess Critical Knowledge & Product Architecture

	DEPENDENT FOR KNOWLEDGE & CAPACITY	INDEPENDENT FOR KNOWLEDGE & DEPENDENT FOR CAPACITY	INDEPENDENT FOR KNOWLEDGE & CAPACITY
ITEM IS MODULAR	A POTENTIAL OUTSOURCING TRAP	BEST OUTSOURCING OPPORTUNITY	OVERKILL IN VERTICAL INTEGRATION
ITEM IS INTEGRAL	WORST OUTSOURCING SITUATION	CAN LIVE WITH OUTSOURCING	BEST INSOURCING SITUATION

Adapted from Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

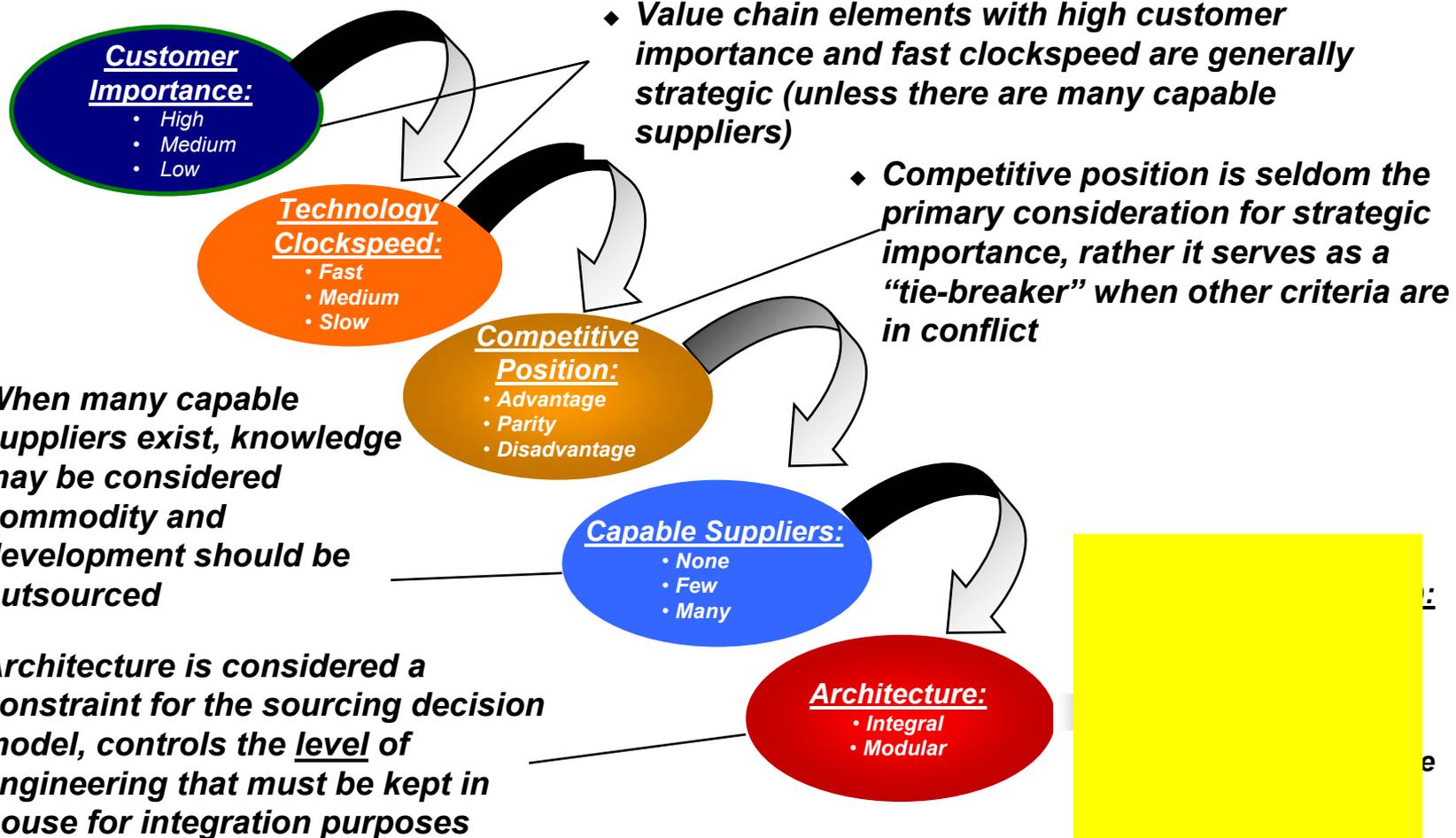# Strategic Make/Buy Decisions:
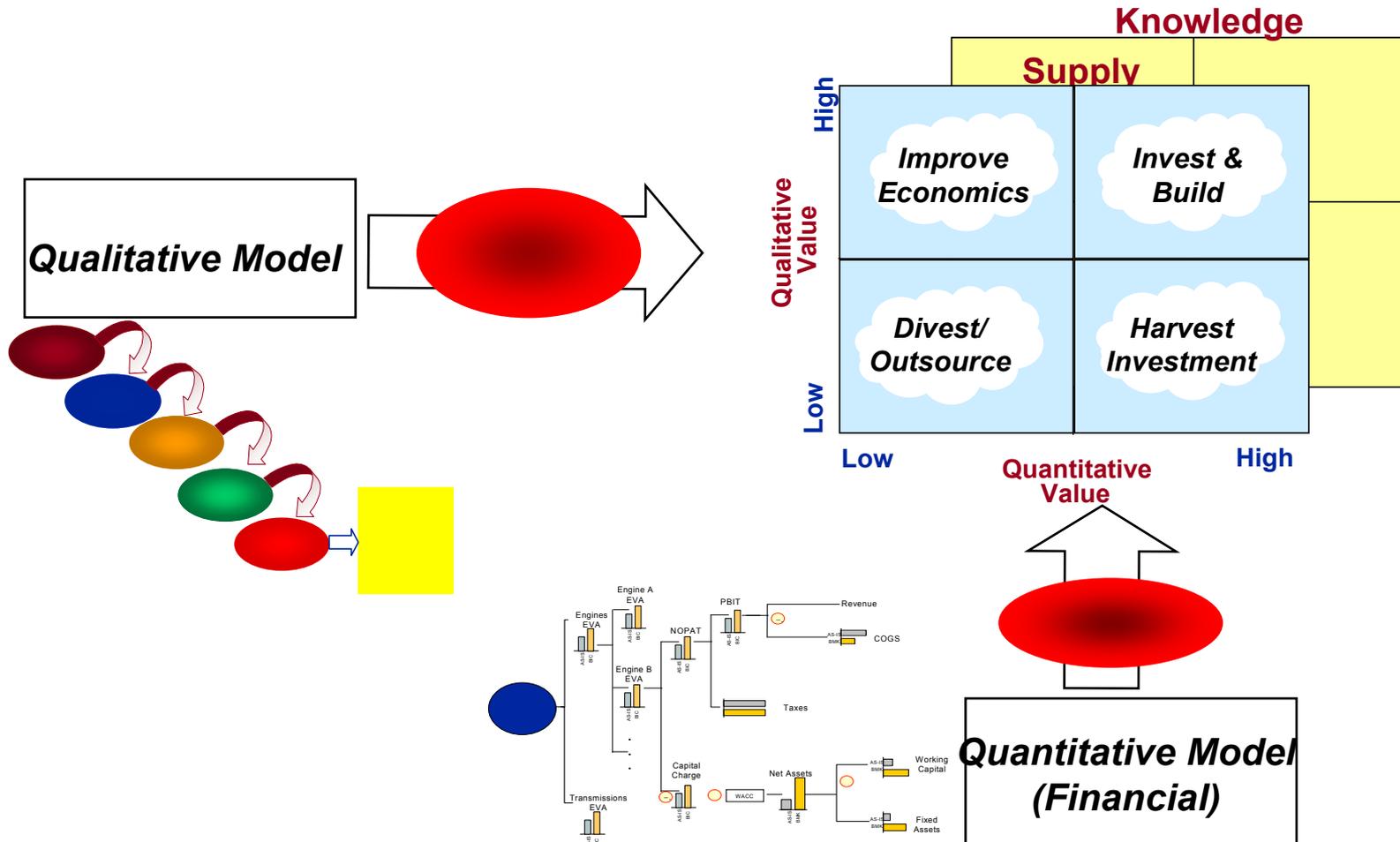## Also consider Clockspeed & Supply Base Capability

	DEPENDENT FOR KNOWLEDGE & CAPACITY	**DEPENDENT FOR CAPACITY ONLY**	**INDEPENDENT FOR KNOWLEDGE & CAPACITY**
DECOMPOSABLE (Modular)	*Trap* — Clockspeed *Fast Slow* / Suppliers *Few Many* — *OK* / *Watch it!*	*Best Out* — Clockspeed *Fast Slow* / Suppliers *Few Many*	*Over-kill* — Clockspeed *Fast Slow* / Suppliers *Few Many*
INTEGRAL	*Worst* — Clockspeed *Fast Slow* / Suppliers *Few Many*	*OK* — Clockspeed *Fast Slow* / Suppliers *Few Many*	*Best-In* — Clockspeed *Fast Slow* / Suppliers *Few Many*

Adapted from C. Fine, *Clockspeed*, Chap. 9

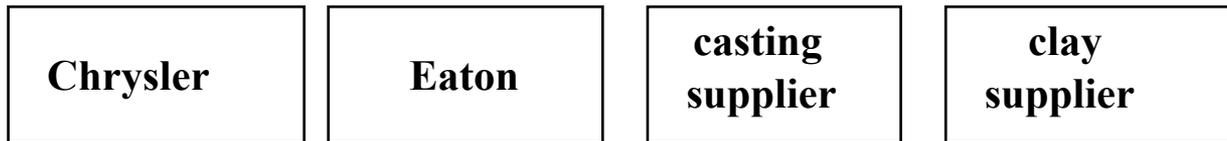# Qualitative analysis of strategic importance uses five key criteria

Customer Importance:
- High
- Medium
- Low

Technology Clockspeed:
- Fast
- Medium
- Slow

Competitive Position:
- Advantage
- Parity
- Disadvantage

Capable Suppliers:
- None
- Few
- Many

Architecture:
- Integral
- Modular

◆ *Value chain elements with high customer importance and fast clockspeed are generally strategic (unless there are many capable suppliers)*

◆ *Competitive position is seldom the primary consideration for strategic importance, rather it serves as a "tie-breaker" when other criteria are in conflict*

◆ *When many capable suppliers exist, knowledge may be considered commodity and development should be outsourced*

◆ *Architecture is considered a constraint for the sourcing decision model, controls the level of engineering that must be kept in house for integration purposes*

Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

Every decision requires qualitative and quantitative analysis to reach a conclusion

Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

Value Chain Mapping

Organizational Supply Chain

Chrysler	Eaton	casting supplier	clay supplier

Technology Supply Chain

engines	valve lifters	casting manufacturing process	clay chemistry

Capability Chain

| Supply Chain Management	Quality assurance	NVH engineering	R&D
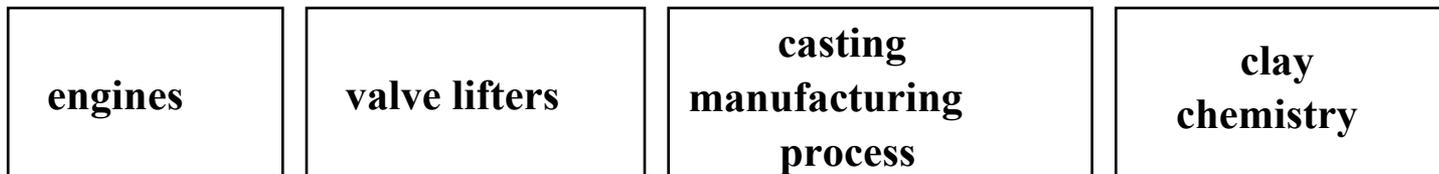
**Underlying Assumption: You have to draw
the maps before you can assess their dynamics.**

VALUE CHAIN DESIGN IS
THE ULTIMATE CORE COMPETENCY

Since all advantages are temporary,
the only lasting competency is to continuously build and
assemble capabilities chains.

KEY SUB-COMPETENCIES:

1. Forecasting the dynamic evolution of market power and market opportunities

2. Anticipating Windows of Opportunity

3. 3-D Concurrent Engineering:
Product, Process, Value Chain

PROJECTS
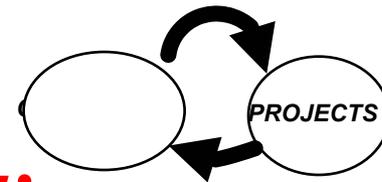
Fortune Favors the Prepared Firm

PROCESS FOR
VALUE CHAIN DESIGN

1. Benchmark the **Fruit Flies**
2. Map your Supply Chain
      -Organizational Value Chain
      -Technology Value Chain
      -Competence Chain
3. Dynamic Chain Analysis
      at each node of each chain map
4. Identify **Windows of Opportunity**
5. Exploit **Competency Development Dynamics**
      with **3-D Concurrent Engineering**

DOUBLE HELIX

BOEING

CAPABILITIES   PROJECTS
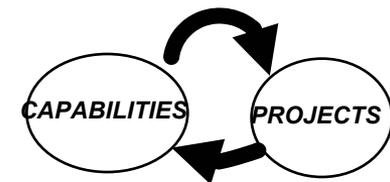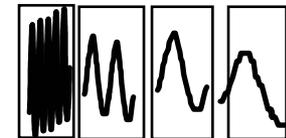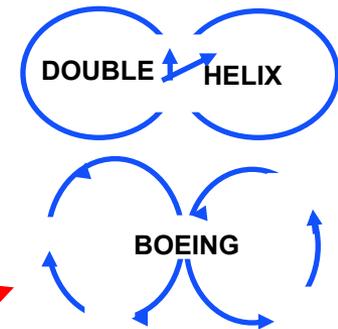
STRATEGY IN 3-D: CASE EXAMPLES

Boeing: Static 3-D in airplane Projects
Dynamic, Strategic Value Chain,
unintegrated w/ Product & Process

Intel: Modular Product vs. Process
Integral Process and Value Chain

Chrysler: Modular Product & Value Chain
(weak on process?)

Toyota: Integral 3-D in Nagoya
(weak on global 3-D?)

Exercise 2:
Value Chain Analysis

Consider these five industries:

- -Food
- -Defense aircraft
- -Automobiles
- -Handheld electronic organizers/communicators
- -Music

At each table, pick two of these industries:

What are the key dependency relationships in the value chain?

What is driving the clockspeed in the chain?

What are the opportunities for outsourcing
to contract manufacturers

What are the windows of opportunity in the chain?

Strategic Supply Chain Design

1. **Fruit Flies & Supply Chain Evolution**

2. **Supply Chain Design & 3-DCE**

3. **Customer Service and Service Supply Chains**

4. **Value Chain Roadmapping**

Internet Era Phenomena:
eCompetition in Business Model Innovation

Benchmarking the eFlies

E-tailing:
   Attack:
      Amazon, Webvan Market disruption in hopes of making a place
   Defend:
      Walmart.com, Ford.com Defense can require costly SC revamping

B2B:
   E2E integration:
      Cisco, Dell Integration pays off with modular products
   Marketplace Creation:
      Freemarkets Reverse auctions reduce short term costs
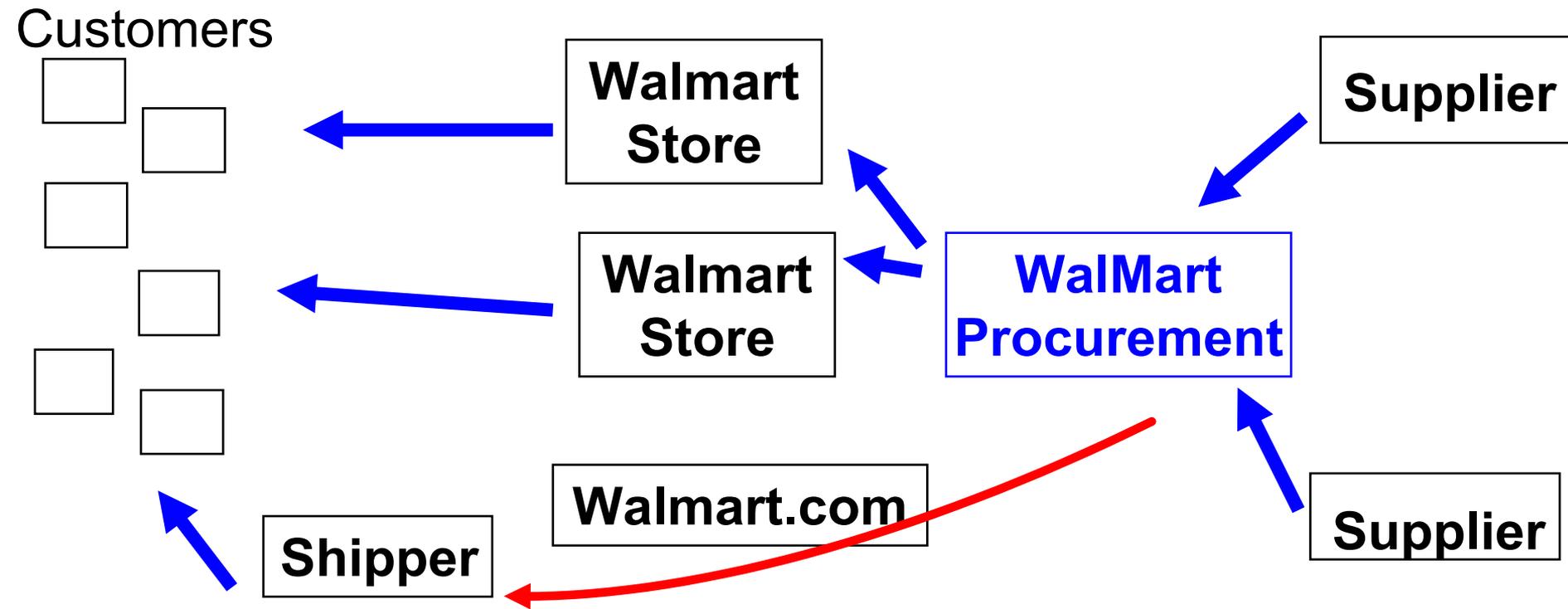   **Covisint** Common standards reduced supplier investment cost

Free & Open Digital Content:

   Peer-toPeer Sharing/Theft:
      Napster Industry-shaking disruptions require value chain SWAT team

DOT.COM COMPETITION: FOCUS ON THE SUPPLY CHAIN

CASE#1: WALMART.COM GOT NO TRACTION

Customers

Walmart Store	**Supplier**
Walmart Store	**WalMart Procurement**
Shipper **Walmart.com**	**Supplier**

Alternate Solution: Partner with UPS or Fedex

SERVICES VS. MANUFACTURING

WHAT'S THE DIFFERENCE?

Some Characteristics of Services

- **Intangibility - explicit and implicit intangibles**
  - **"We manufacture perfume; we sell hope."**
- **Perishability - an hour of non-production is an hour lost**
  - **Airplane w/o spare part costs > $10K/hr**
- **Heterogeneity - inherent variability of personal needs and personal service**
  - **Each doctor's bedside care is unique**
- **Simultaneity - services are simultaneously produced and consumed**
  - **A poor attitude by the server cannot be recalled**

Services vs. Manufacturing

Dell Product Features
- μP & modem speed
- CD ROM speed
- MB DRAM & HD
- screen size
- order-to-deliv time
- features range
- fulfillment accuracy

Airline Product Features
- check-in time
- reservations help
- meals
- price
- flight frequency
- mileage awards
- route coverage
- baggage handling
- customer coddling

ON-LINE and IN-STORE GROCERY SERVICES

TESCO	*STOP & SHOP/AHOLD*	*WEBVAN*
Tesco on-line	**Peapod**	**Last-mile provider**

•**24/7 operations**
•**Low capital cost**
•**Pick off the floor;**
   - **"steals" floor stock**
   - **adds floor congestion**
•**Weak inventory control**
•**Messy; 1.3% waste**
•**High Monday out-of-stock**
	•**24/7 web; 16 hours/day**
	•**Low capital cost**
	•**Pick off dedicated section**
	•**Limited menu**
	•**Peapod dedicated team**
	•**$200K/wk peapod-B/E**
	•**$1M/wk store floor**
	•**Spotlessly clean**
		•**24/7 web**
		•**Dedicated network**
		•**High capital cost**
		•**Utilization sensitive**
		•**No startup slack**
		•**Unrealistic promises**
		  -**to customers**
		  -**to investors**

Challenges of Service Interface: Grocery Stores vs. Webvan

- **Intangibility** - customer expectations vs. perceptions
  - **Grocery Stores: quality, selection, _ENVIRONMENT_**
  - **Webvan: quality, selection, _DELIVERY_**
- **Perishability** - use it or lose it
  - **Grocery Stores: fresh foods (produce, meats, baked goods)**
  - **Webvan: fresh foods & _TRUCK CAPACITY_**
- **Heterogeneity** - inherent variability of service & customer
  - **Grocery: checkout people, counter people, customer needs**
  - **Webvan: _DELIVERY PERSON_**
- **Simultaneity** - services simultaneously produced & consumed
  - **Grocery: presentation in the store**
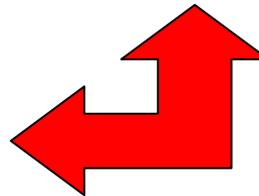 - **Webvan: _DELIVERY TO THE HOME_**

On-line vs. In-store Groceries

Webvan Features
- selection
- price
- quality/freshness
- shop any hour
- never leave home
- choose delivery time
- save your time
- same day delivery
- fulfillment accuracy
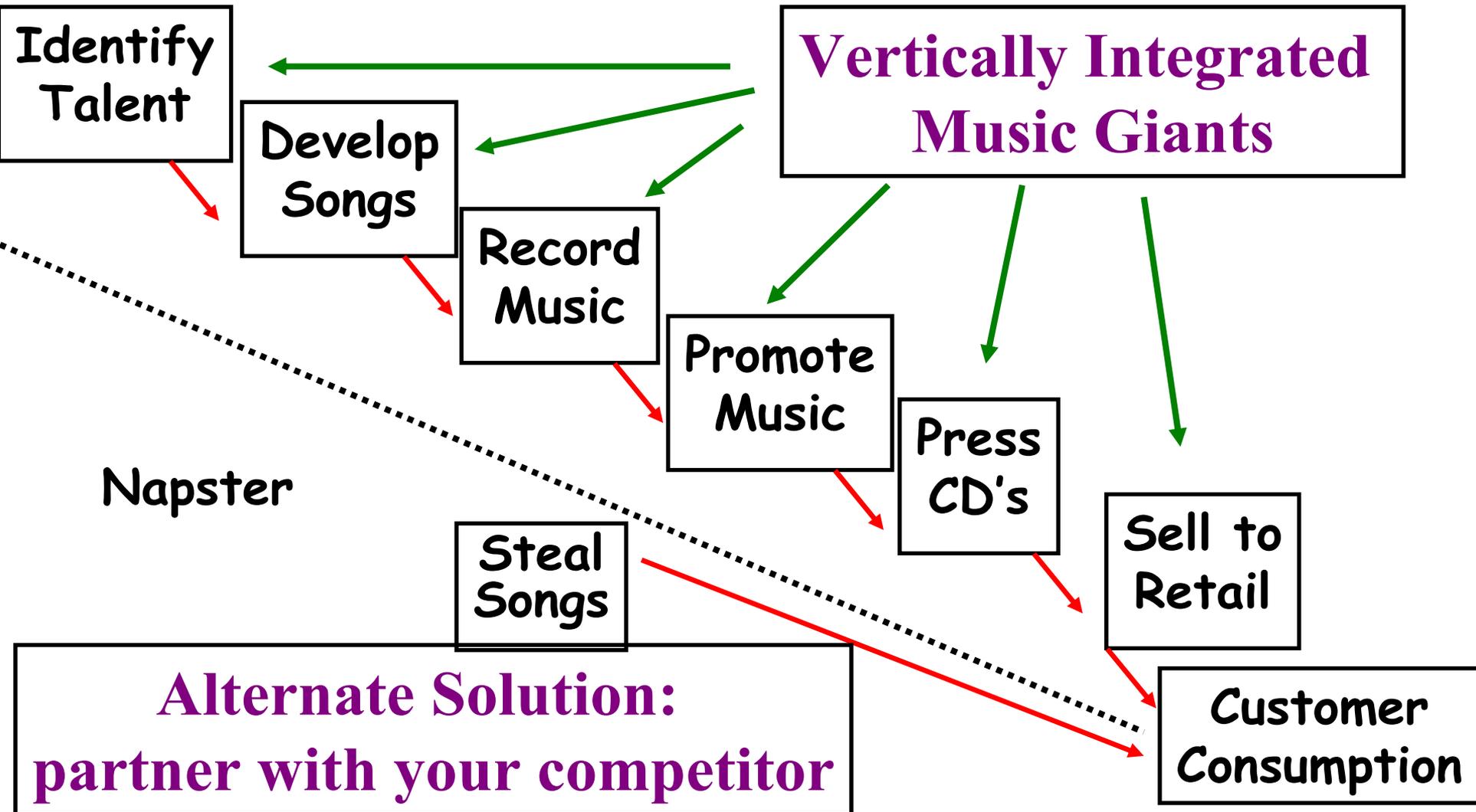- no lugging required

Grocery Store Features
- selection
- price
- quality/freshness
- shopping environment

Who has the advantage on each dimension?

DOT.COM COMPETITION: FOCUS ON THE SUPPLY CHAIN
Napster's New Supply Chain Strategy
(go to the end and steal everything!)

Identify Talent

Develop Songs

Record Music

Promote Music

Press CD's

Sell to Retail

Vertically Integrated Music Giants

Napster

Steal Songs

Alternate Solution: partner with your competitor

Customer Consumption

Exercise 3:
Service Supply Chains

Consider these five industries:

  -Food

  -Defense aircraft

  -Automobiles

  -Handheld electronic organizers/communicators

  -Music

At each table, pick two of these industries:
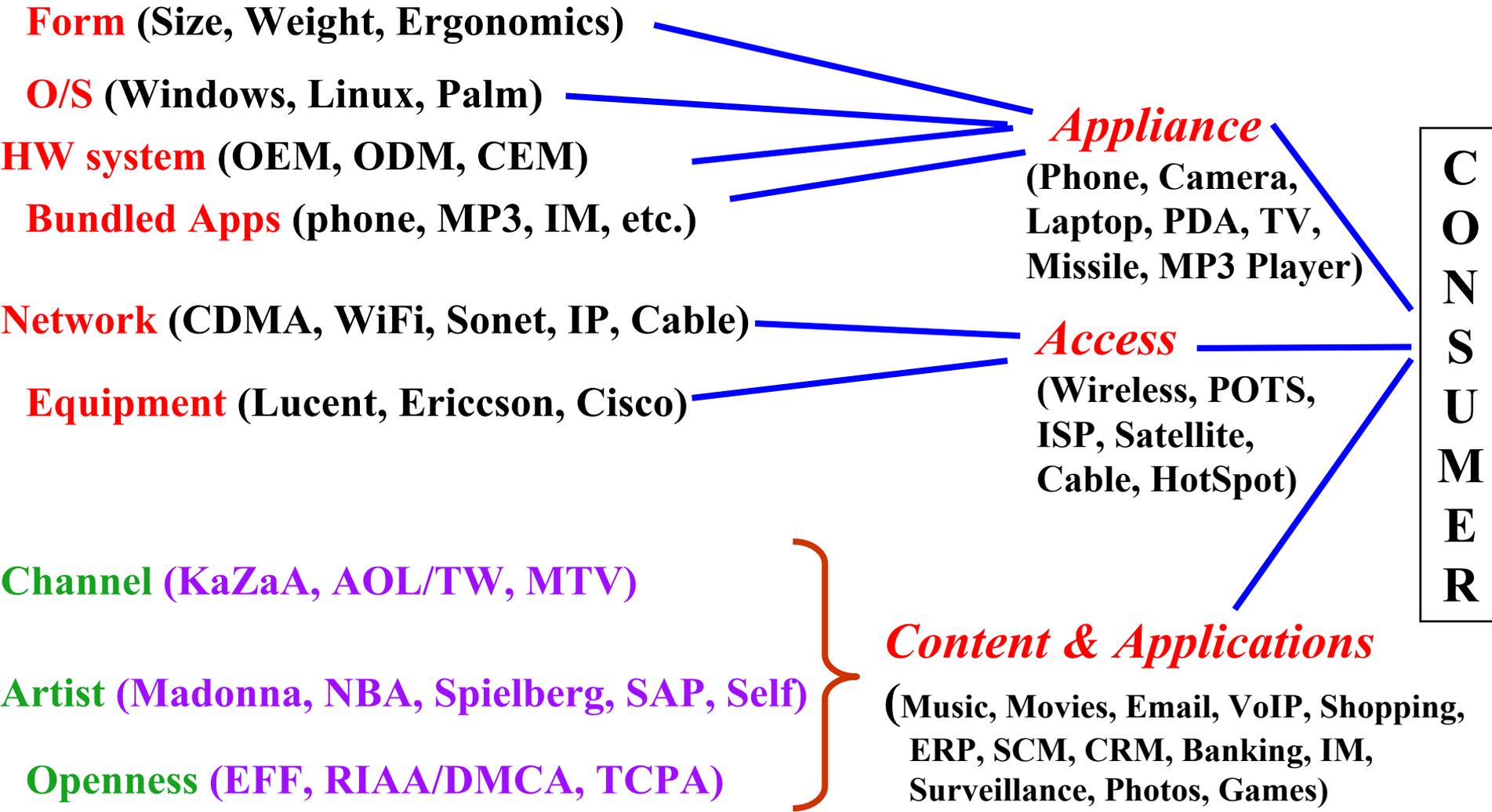
  What are the key service elements in the value chain?

  What are the challenges of managing these services?

Strategic Supply Chain Design

1. Fruit Flies & Supply Chain Evolution

2. Supply Chain Design & 3-DCE

3. Customer Service and Service Supply Chains

4. Value Chain Roadmapping in Communications
    (Architectures and Roadmaps
        for Communications and Media)

One View (the consumer's) of the Communications Value Chain

Form (Size, Weight, Ergonomics)

O/S (Windows, Linux, Palm)

HW system (OEM, ODM, CEM)

Bundled Apps (phone, MP3, IM, etc.)

Network (CDMA, WiFi, Sonet, IP, Cable)

Equipment (Lucent, Ericcson, Cisco)

Channel (KaZaA, AOL/TW, MTV)

Artist (Madonna, NBA, Spielberg, SAP, Self)

Openness (EFF, RIAA/DMCA, TCPA)

Appliance
(Phone, Camera, Laptop, PDA, TV, Missile, MP3 Player)

Access
(Wireless, POTS, ISP, Satellite, Cable, HotSpot)

Content & Applications
(Music, Movies, Email, VoIP, Shopping, ERP, SCM, CRM, Banking, IM, Surveillance, Photos, Games)

CONSUMER

Another View of the Communications Value Chain

| MATERIALS & PROCESS EQUIP	COMP-ONENTS	EQUIPMENT MAKERS	NETWORK OWNERS	SERVICE PROVIDERS	CONTENT & APPLICS	APPLI-ANCES	END USERS
•Silicon •Gaas •InP •Polymers •Steppers •Etchers •MEMS •Insertion •Etc..	•Lasers •Amplifiers •Transceiver •Filters •Processors •Memories •Fiber •ASICS •MEMS •DSP's •Etc..	•Routers •Switches •Hubs •Base Stations •Satellites •Servers •Software •O/S •Etc..	•Wireless •Backbone •Metro •Access •Substations •Satellites •Broadcast Spectrum •Communic Spectrum •Etc..	•Long dist. •Local •Cellular •ISP •Broadcast •Hot Spots •Cable TV •Satellite TV •VPN's •MVNO's •Etc..	•Music •Movies •Email •VoIP •POTS •Shopping •ERP •SCM, CRM •Surveillance •eBusiness •Etc..	•Computers •Phones •Media Players • Cameras •PDA's •Weapons •Etc..	•Business •Consumer •Gov't •Military •Education •Medical •Etc..

Roadmapping Communications: What are the Premises?

Communications Value Chain is in ill health
(ROADKILL MAPPING?)

Vertical *dis*integration is the dominant structure. Silo execs tend to focus on their own narrow slices. **Most industry consortia are *within*-silo.**
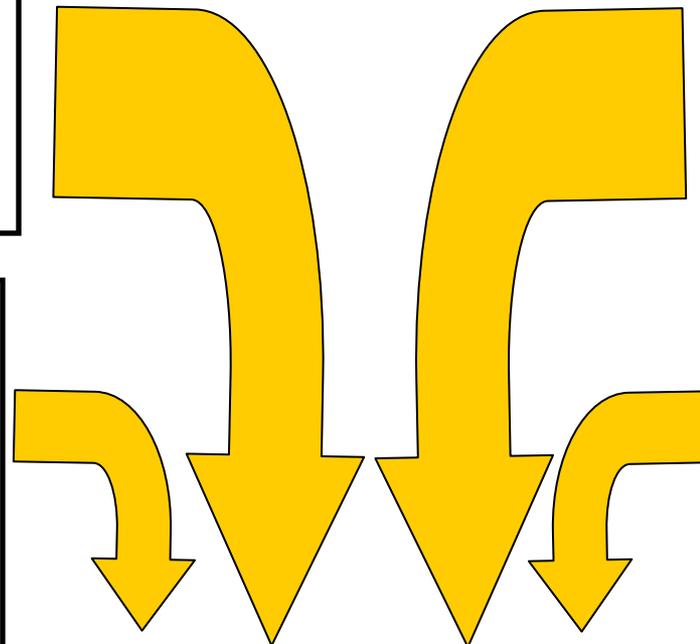
SOME VALUE CHAIN COORDINATION COULD SPEED GROWTH.

**Silos in the value chain are interdependent (integrality).**

Absence of leadership and coordination across an interdependent value chain creates uncertainty, risk, and reluctance to invest.

HOW TO ACHIEVE COORDINATION IN THE ABSENCE OF VERTICAL INTEGRATION?

Roadmapping Communications: What are the Premises?

Technology dynamics, Industry dynamics, and Regulatory dynamics are interdependent.

Technology and industry roadmapping are typically done by different people
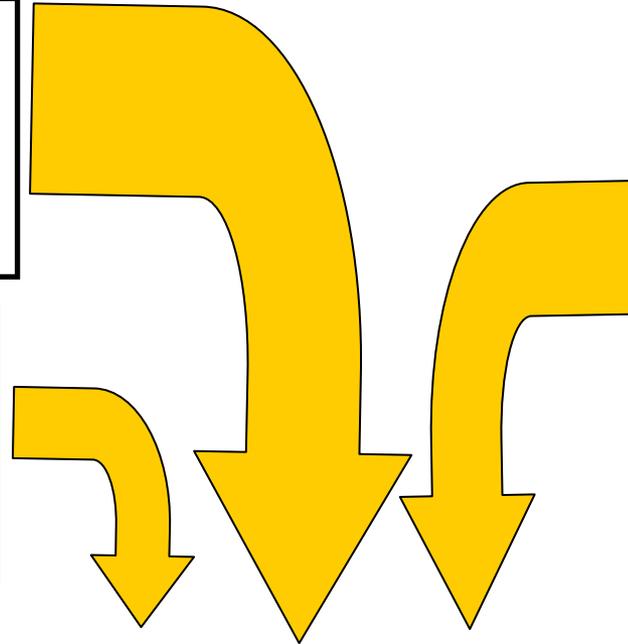
SIA roadmaps provided productive coordination in semiconductors, but focused only on technology & a narrow slice of the value chain. Industry growth was assumed.

--> Not a good model for Communications.

Productive roadmapping must encompass multiple links of the value chain, a multidisciplinary team, and the co-evolution of technology, industry, and regulatory policy.

"If you come to a fork in the Road[map], Take it."
--Yogi Berra

Internet explosion
Wireless Explosion
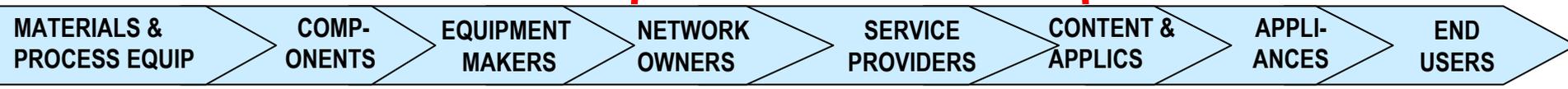**Connectivity Explosion**
File Sharing Explosion

INFORMATION WANTS TO BE SHARED
==> **Difficult content business models**

INFORMATION SHARERS GO TO JAIL
==> **Poverty of The Commons**

"If you come to a fork in the Road[map], Take it."
--Yogi Berra

INFORMATION WANTS TO BE SHARED
==> **Difficult content business models**

**Internet explosion
Wireless Explosion
Connectivity Explosion
File Sharing Explosion**

Is there a third way? (Quantum Roadmap)

INFORMATION SHARERS GO TO JAIL
==> **Poverty of The Commons**

MPC, MTL — RLE — ITC — LCS — eBusiness, Oxygen, Media Lab

MATERIALS & PROCESS EQUIP	COMP-ONENTS	EQUIPMENT MAKERS	NETWORK OWNERS	SERVICE PROVIDERS	CONTENT & APPLICS	APPLI-ANCES	END USERS
•Silicon	•Lasers	•Routers	•Wireless	•Long distance	•Music	•Computers	•Business
•Gaas	•Amplifiers	•Switches	•Backbone	•Local Phone	•Movies	•Phones	•Consumer
•InP	•Transceiver	•Hubs	•Metro	•Cellular	•Email	•Media	•Gov't
•Polymers	•Filters	•Base Stations	•Access	•ISP	•VoIP	Players	•Military
•Steppers	•Processors	•Satellites	•Substations	•Broadcast	•POTS	• Cameras	•Education
•Etchers	•Memories	•Servers	•Satellites	•Hot Spots	•Shopping	•PDA's	•Medical
•MEMS	•Fiber	•Software	•Broadcast	•Cable TV	•ERP	•Weapons	•Etc..
•Insertion	•ASICS	•O/S	Spectrum	•Satellite TV	•SCM, CRM	•Etc..	
•Etc..	•MEMS	•Etc..	•Communic	•VPN's	•Surveillance		
	•DSP's		Spectrum	•MVNO's	•eBusiness		
	•Etc..		•Etc..	•Etc..	•Etc..		

CROSS-INDUSTRY CHALLENGES

Digital Rights ("To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries;" U.S. Constitution, Article 1, Section 8, Clause 8 **)**

Access Architecture

Prof. C. Fine, MIT

Dynamic Analysis to Support Industry & Technology Roadmapping
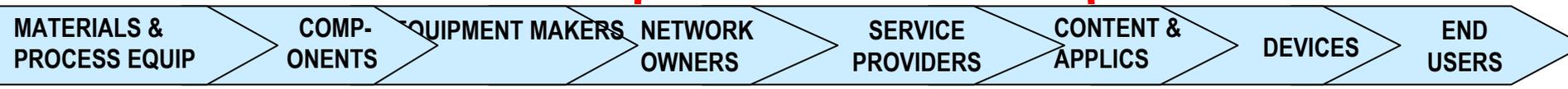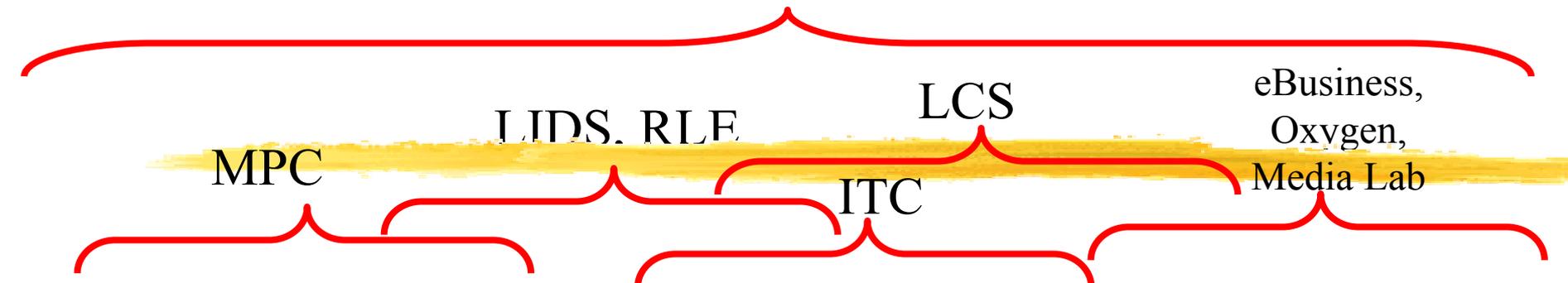
Corporate Strategy Dynamics

Customer Preference Dynamics

Technology Dynamics

Regulatory Policy Dynamics

Industry Structure Dynamics

Capital Market Dynamics

Business Cycle Dynamics

MIT Communications Roadmap Consortium

MPC

LIDS, RLE

LCS

ITC

eBusiness, Oxygen, Media Lab

MATERIALS & PROCESS EQUIP	COMP-ONENTS	EQUIPMENT MAKERS	NETWORK OWNERS	SERVICE PROVIDERS	CONTENT & APPLICS	DEVICES	END USERS
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Access Architecture

C. Fine, MIT

Roadmap Components: Dynamic Analyses

1. Business cycle dynamics
   (e.g., the bullwhip effect)
2. Industry structure dynamics
   (e.g., double helix in *Clockspeed*)
3. Corporate strategy dynamics (e.g., dynamic matching
   of customer needs with corporate opportunities)
4. Customer Preference Dynamics
5. Technology dynamics (e.g., the Semiconductor
   Industry Assoc. roadmap built around Moore's law)
6. Regulatory Policy Dynamics
   (Cross-National, Cross Sector)
7. Capital Markets Dynamics

Business Cycle Dynamics
"The Bullwhip Effect"
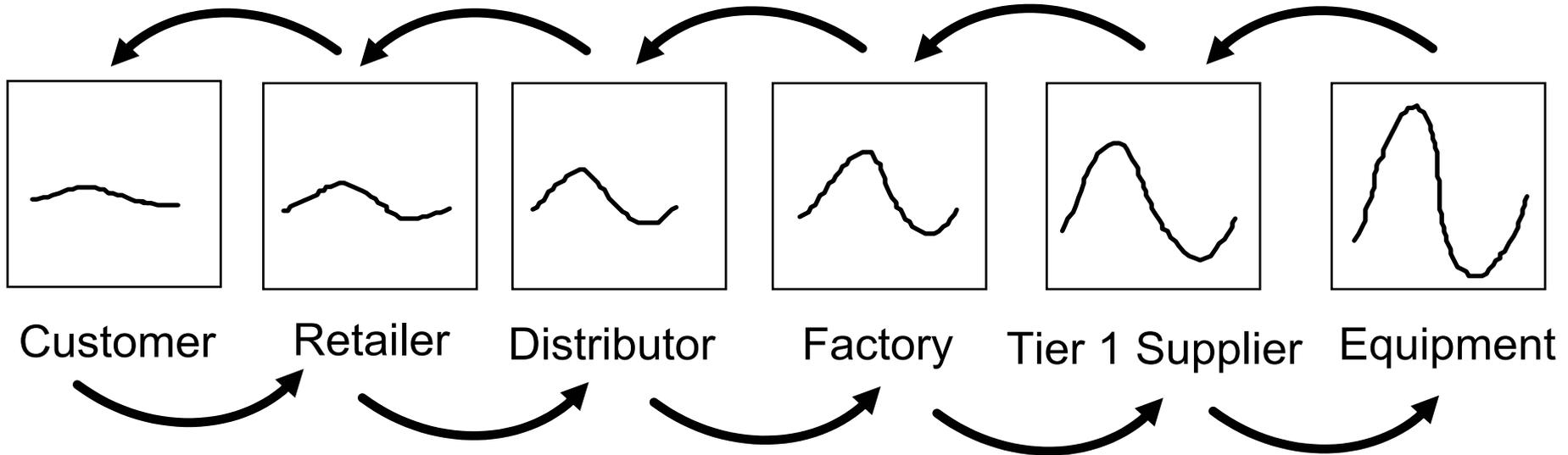
| Customer | Retailer | Distributor | Factory | Tier 1 Supplier | Equipment |

Information lags
Delivery lags
Over- and underordering
Misperceptions of feedback
Lumpiness in ordering
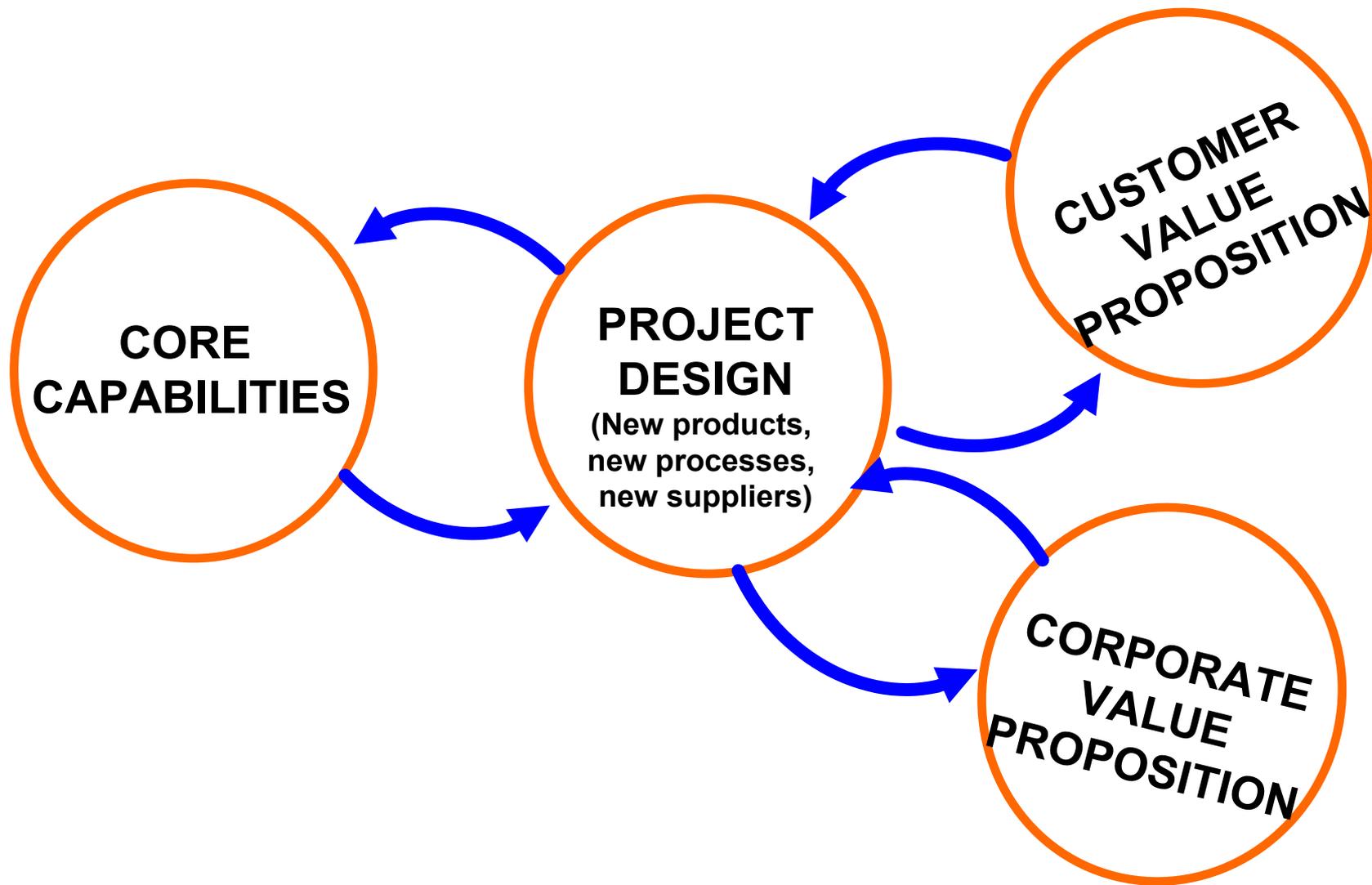Chain accumulations

SOLUTIONS:
Countercyclical Markets
Countercyclical Technologies
Collaborative channel mgmt.
(Cincinnati Milacron & Boeing)

Industry Structure Dynamics

See Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

Corporate Strategy Dynamics

CORE CAPABILITIES

PROJECT DESIGN
(New products,
new processes,
new suppliers)

CUSTOMER VALUE PROPOSITION

CORPORATE VALUE PROPOSITION

Corporate Strategy Dynamics

TECHNOLOGY/PRODUCT ARCHITECTURE

BUSINESS SYSTEM/SUPPLY CHAIN ARCHITECTURE
(Geog., Organ., Cultural, Elec.)

INTEGRAL ⟷ MODULAR

	INTEGRAL		MODULAR
INTEGRAL	Microprocessors Mercedes & BMW vehicles	Lucent Nortel	Polaroid
	MSFT Windows	Chrysler vehicles	Cisco
MODULAR	Digital Rights/ Music Distribution		Dell PC'S Bicycles

Customer Preference Dynamics
(adapted from Sadek Esener, UCSD and
Tom O'Brien, Dupont "Macro-Trends" process)

1. **Population**
    - **Aging, Growth**
2. **Awareness**
    - **of Environment/Energy costs, Personal Health**
    - **of consumption possibilities & disparities**
3. **Globalization**
    - **of commerce, culture, knowledge, disease, terrorism**
4. **Clusters**
    - **urbanization**
    - **wealth**
    - **affinity/ethnic groups**
5. **Technology**
    - **cheap computation, pervasive connectivity**
    - **technology at the molecular (nano) level**
      (life sciences, electronics, polymers)

Regulatory Policy Dynamics: Some Components

1. **Players:**
   United States: FCC, Congress, Consumers,
      Corporations, Interest Groups
2. **Environments:**
   Wireless in Europe, NTT DoCoMo,
   Broadband in Sweden & Korea
   India vs. China Development
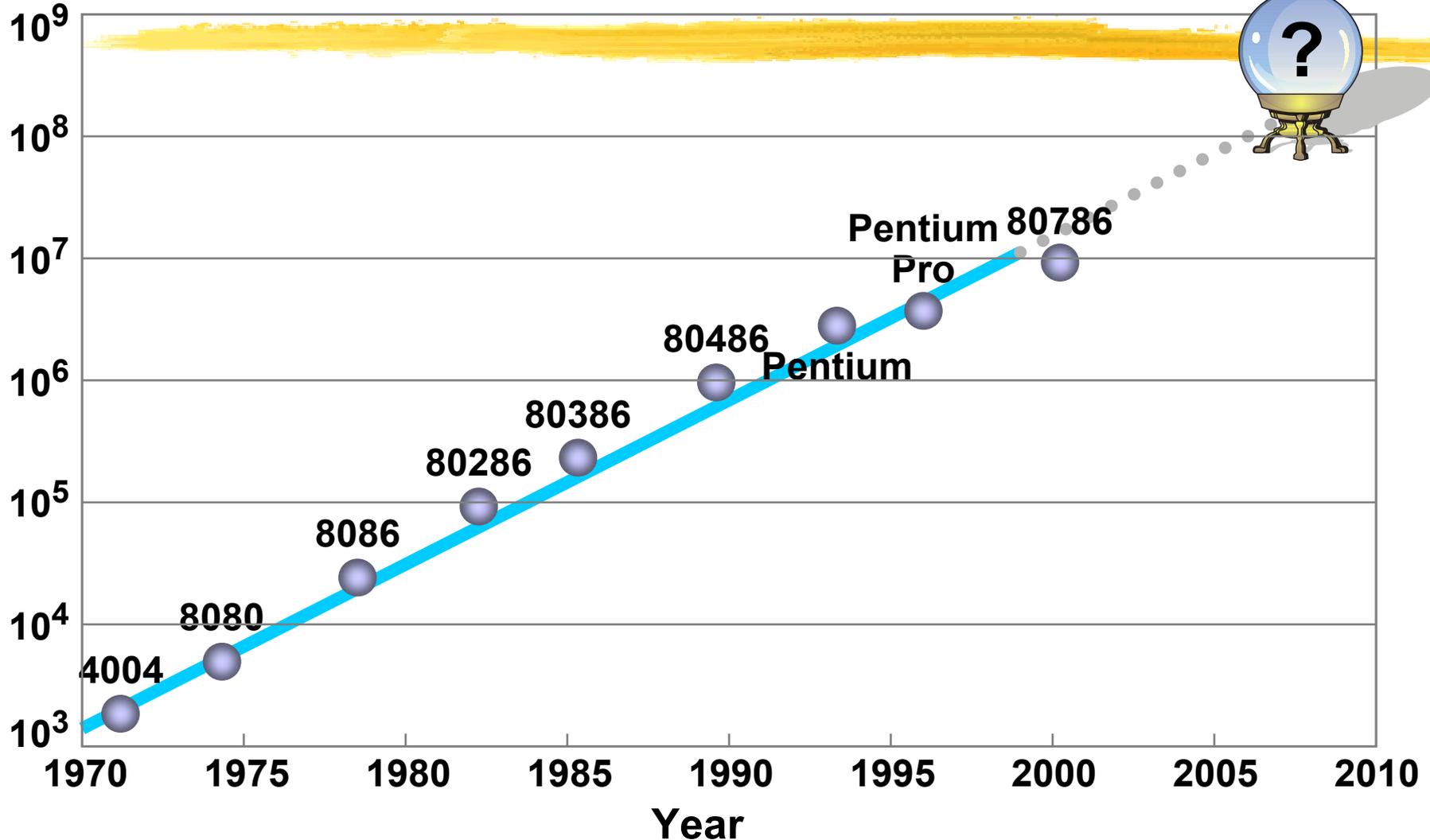   US: Access, Digital Rights
3. **Standards:**
   e.g., wCDMA vs CDMA2000

Technology Dynamics: Moore's Law predictions are linear & deterministic

Transistors per chip

Source: Joel Birnbaum, HP, Lecture at APS Centennial, Atlanta, 1999

Technology Dynamics: Disk Drive Development is non-linear & non-deterministic

Disk Drive Generation	Dominant Producer	Dominant Usage	Approx cost per Megabyte
14"	IBM	mainframe	$750
8"	Quantum	Mini-computer	$100
5.25"	Seagate	Desktop PC	$30
3.5"	Conner	Portable PC	$7
2.5"	Conner	Notebook PC	$2

1978-1991

From 1991-98, Disk Drive storage density increased by 60%/year while semiconductor density grew ~50%/year. Disk Drive cost per megabyte in 1997 was ~ $ .10

"Killer Technologies" of the Information Age: Semiconductors, Magnetic Memory, Optoelectronics

"We define a _'killer technology'_ as one that delivers enhanced systems performance of a factor of at least a hundred-fold per decade."

C.H.Fine & L.K. Kimerling, "Biography of a Killer Technology: Optoelectronics Drives Industrial Growth with the Speed of Light," published in 1997 by the Optoelectronics Industry Development Association, 2010 Mass Ave, NW, Suite 200, Wash. DC 20036-1023.

Killer Questions:

1. Will _Integrated Optics_ evolve linearly like Semiconductors with Moore's Law or like Disk Drives with repeated industry disruptions?

2. How do we distinguish between the types?

OPTICAL VALUE CHAIN:
MINI CASE EXAMPLE

NORTEL NETWORKS plays at at least three levels of the Optical Network Telecom value chain:

1. Network design & installation
2. Modules (OC-192 network elements)
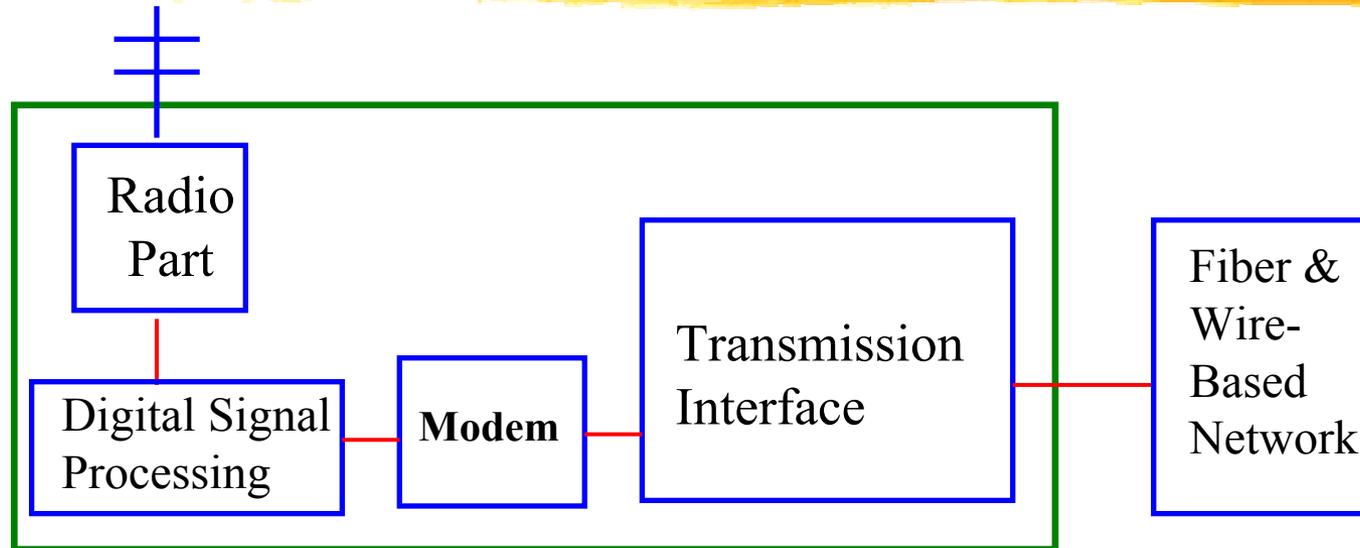3. Components (lasers, amplifiers)

QUIZ: Should Nortel sell their components business?

Hint: How likely are the scenarios of:

  - An *Intel Inside* effect in components?
  - Networks become sufficiently modular as to be assembled by the customer?

WIRELESS VALUE CHAIN: MINI CASE EXAMPLE

Wireless Base Stations (WSB'S) comprise 4 key subsystems:

```
          ╪
   ┌──────────────┐
   │   Radio      │
   │   Part       │
   └──────────────┘
   ┌──────────────┐   ┌────────┐   ┌─────────────────┐   ┌──────────┐
   │ Digital Signal│  │ Modem  │   │ Transmission    │   │ Fiber &  │
   │ Processing   │   │        │   │ Interface       │   │ Wire-    │
   └──────────────┘   └────────┘   └─────────────────┘   │ Based    │
                                                          │ Network  │
                                                          └──────────┘
```

WSB architectures are
      -integral & proprietary
Suppliers include: Nortel,
Moto, Ericsson, Siemens, Nokia
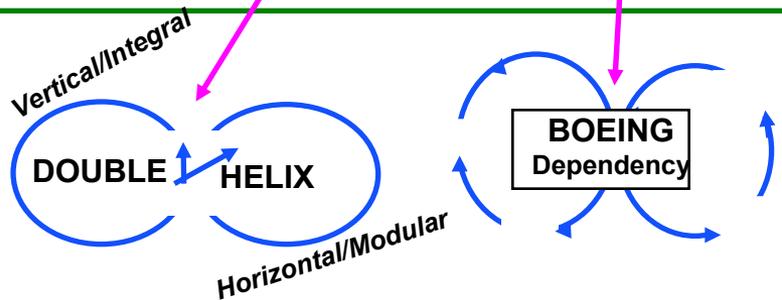**Disruptive Modem advances**
      (e.g., MUD) can double
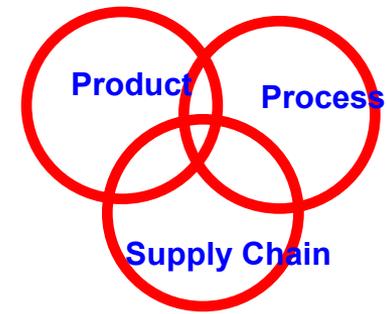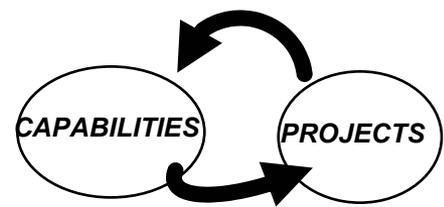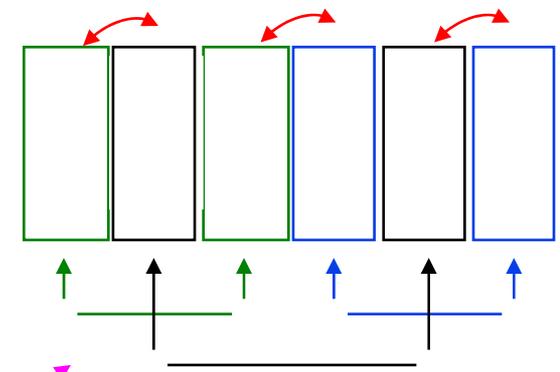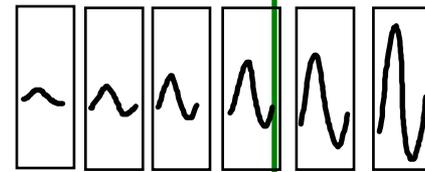   **Base Station Capacity**

Modular WSB's might
  (1) Stimulate new WSB entrants (ala Dell)
  (2) Stimulate standard subsystem suppliers
  (3) lower prices to the network operators
  (4) Speed base station performance imp.
  (5) Increase demand for base stations due
      to improved price-performance ratios.

Supply Chain Design is the Ultimate Core Competency: *Competency of passing judgement on all other competencies*

Benchmark the Fruit Flies
- **Beware of *Intel Inside***
- **SC control point unstable (comp, assem, distrib)**
- **SC structures oscillate**
  -- int/int or mod/mod
- **The Bullwhip lives**
- **Dependence/Independence has positive feedback**
- **Projects feed capabilities & vice-versa**
- **eBusiness accelerates Clockspeeds**
- **All Advantage is Temporary**
- **Align Architectures in Pdt, Proc, & SC**
- **Tech & Comp drive clockspeeds**

CAPABILITIES   PROJECTS

Product   Process

Supply Chain

Vertical/Integral

DOUBLE   HELIX

Horizontal/Modular

BOEING
Dependency

All Conclusions are *Temporary*

Clockspeeds are increasing almost everywhere

**Many technologies and industries exhibit fast clockspeed & high volatility**

Value chain design and service system key competencies

Study of Fruit Flies can help with crafting strategy

Mother Nature strikes
The Cell Phone Supply Chain

8:00 pm, Friday 17 March 2000: Lightning Strikes an ASIC semiconductor plant of Philips in Albuquerque, New Mexico, USA 8:10 pm: Fire is extinguished. Plant will be down for months.
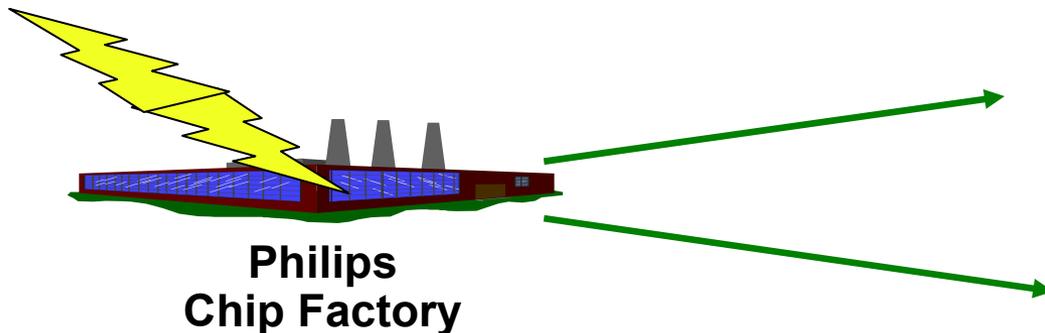
Philips Chip Factory

Ericsson Cell Phones

Nokia Cell Phones

LESSON: RESPONSE SPEED
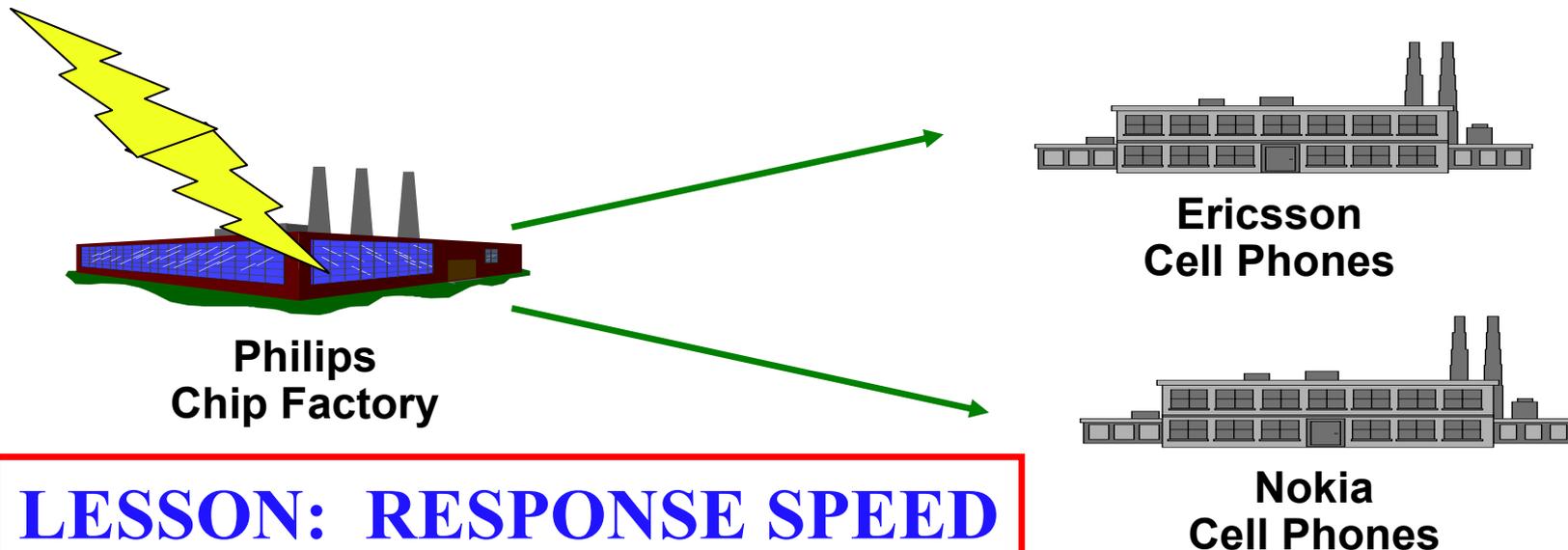
Mother Nature strikes
The Cell Phone Supply Chain

NOKIA

Shipment discrepancies noticed within 3 days.
Philips is pushed hard.
New supply sources.
New chip design.
Global capacity grab.

ERICSSON

Problem undiscovered for weeks.
Slow chain of command.
Slow response.
Capacity already taken.
$400M revenue loss.
Exits phone manufacture.

Philips Chip Factory

Ericsson Cell Phones

Nokia Cell Phones

LESSON: RESPONSE SPEED